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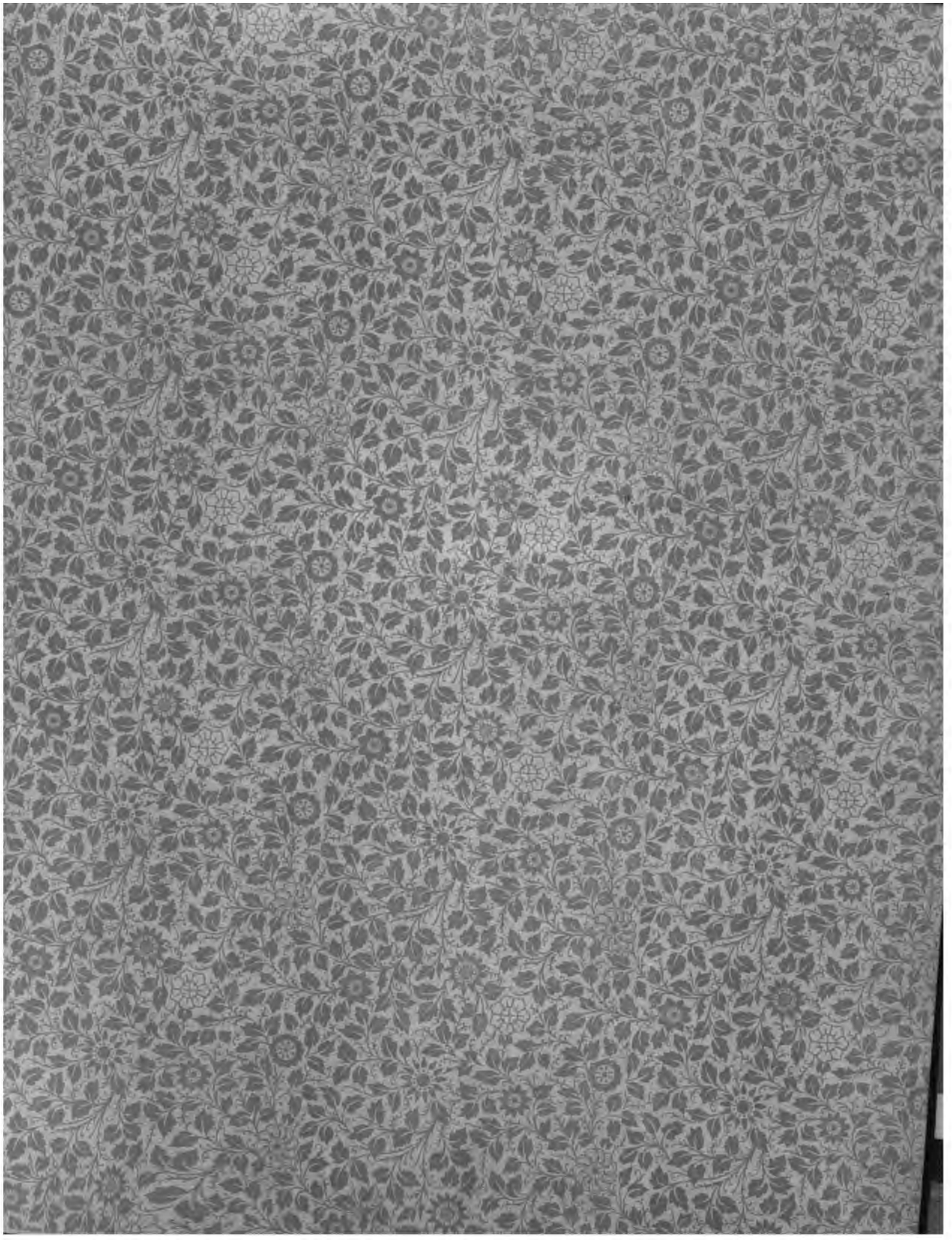

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THE

Westinghouse Air-Brake Co.

PITTSBURGH, PA.

Office and Works: Robinson, Lacock, and Darragh Streets,
Allegheny City, Pa.

OFFICERS:

GEO. WESTINGHOUSE, JR., President.
W. W. CARD, Secretary.
S. H. SPRAGUE, Assistant Secretary.
JOHN CALDWELL, Treas. and Purchaser.
H. H. WESTINGHOUSE, General Agent.
T. W. WELSH, Superintendent.

THE WESTINGHOUSE BRAKE CO. Limited.

Canal Road, Kings Cross,
LONDON.

60 and 62 Rue de la Victoire,
PARIS.

—+—

PITTSBURGH, PENNA.
1882.

FRANCIS L. CLARK, Draughtsman.
ALBERT MARTIN, Engraver,
Pittsburgh, Pa.

PRESS OF
FRANCIS HART & Co. N. Y.

PREFACE.

In the present reference book, which we take pleasure in laying before our friends, we illustrate our automatic brake for passenger and for freight trains, and also show a system of train signaling apparatus, for giving signals from the cars to the engineer, which is designed to take the place of the bell-cord.

The extent to which our brakes have been applied is shown by the list of railways in the appendix, where we also give a list of the patents which we own or under which we have license.

The prices for complete sets are given in the agreement, on pages 14–19, according to the terms of which all our fixtures for passenger equipment are sold.

We hardly think it necessary to say anything in regard to the merits of our automatic brake, as they are well known through its use on most of the prominent lines in this country.

On freight trains we are certain that it will be found quite as advantageous and economical as it has proven itself to be in passenger service, because of the comparative immunity from accidents, while the increased speed at which freight trains can be run with perfect safety will be of the greatest importance. In the item of flattened wheels alone we believe that the cost of the brake will be saved in a very short time, and request a trial of the apparatus, feeling confident that the results will more than uphold us in all of these assertions.

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THE WESTINGHOUSE AUTOMATIC BRAKE.

WE confine ourselves in the descriptive matter of the present work to our automatic brake, the principle of which is illustrated by the drawing shown on Plate A1. The application of this apparatus to an engine is shown on Plate A2, and the application to a car on Plate A3.

The Westinghouse Automatic Brake consists of the following essential parts:

1st. *The Steam Engine and Pump*, which produce the compressed air.

2d. *The Main Reservoir*, in which the compressed air is stored.

3d. *The Engineer's Brake-Valve*, which regulates the flow of air from the main reservoir into the brake-pipe for releasing the brakes, and from the brake-pipe to the atmosphere for applying the brakes.

4th. *The Main Brake-Pipe*, which leads from the main reservoir to the engineer's brake-valve, and thence along the train, supplying the apparatus on each vehicle with air.

5th. *The Auxiliary Reservoir*, which takes a supply of air from the main reservoir, through the brake-pipe, and stores it for use on its own vehicle.

6th. *The Brake-Cylinder*, which has its piston-rod attached to the brake-levers in such a manner that, when the piston is forced out by air pressure, the brakes are applied.

7th. *The Triple Valve*, which connects the brake-pipe to the auxiliary reservoir, and connects the latter to the brake-cylinder, and is operated

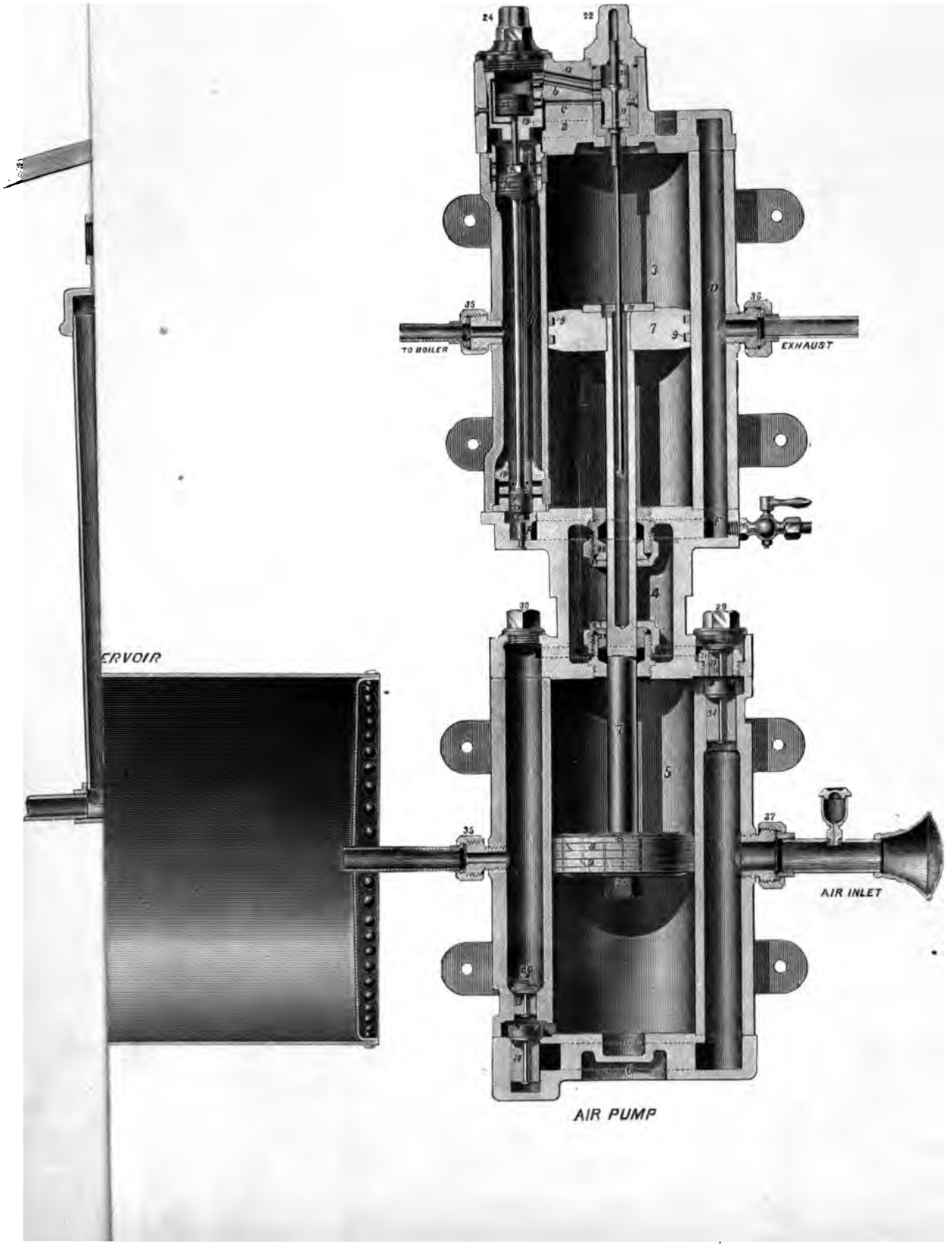
by a sudden variation of pressure in the brake-pipe, (1) so as to admit air from the auxiliary reservoir to the brake-cylinder, which applies the brakes, at the same time cutting off the communication from the brake-pipe to the auxiliary reservoir, or (2) to restore the supply from the brake-pipe to the auxiliary reservoir, at the same time letting the air in the brake-cylinder escape, which releases the brakes.

8th. *The Couplings*, which are attached to flexible hose, and connect the brake-pipe from one vehicle to another.

The automatic action of the brake is due to the construction of the triple valve, the primary parts of which are a piston and a slide-valve. A reduction of pressure in the brake-pipe causes the excess of pressure in the auxiliary reservoir to force the piston of the triple valve down, moving the slide-valve so as to allow the air in the auxiliary reservoir to pass directly into the brake-cylinder and apply the brakes. When the pressure in the brake-pipe is again increased above that in the auxiliary reservoir, the piston is forced up, moving the slide-valve to its former position, opening communication from the brake-pipe to the auxiliary reservoir, and permitting the air in the brake-cylinder to escape, thus releasing the brakes.

Thus it will be seen that *any reduction of pressure in the brake-pipe applies the brakes*, which is the essential feature of the automatic brake. If the engineer wishes to apply the brakes, he moves the handle of the engineer's brake-valve to the right, which first closes a valve retaining the pressure in the main reservoir, and then permits a portion of the air in the brake-pipe to escape. To release the brakes, he turns the handle to its former position, which allows the air in the main reservoir to flow into the brake-pipe, restoring the pressure and releasing the brakes. A valve, called the conductor's valve, is placed in each car, with a cord running the length of the car, and any of the train-men, by pulling this cord, can open the valve, which allows the air to escape from the brake-pipe. Should the train break in two, the air in the brake-pipe escapes, and the brakes are applied to both sections of the train; and should a hose or pipe burst, the brakes are also automatically applied.

The gauge shows the pressure in the main reservoir and brake-pipe when they are connected, and the pressure in the brake-pipe alone when the main reservoir is shut off by the movement of the engineer's brake-valve.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22
TO BOILER
EXHAUST
ERVOIR
AIR INLET
AIR PUMP

RELEASE COCK
MAIN PIPE.

TRIPLE VALVE, RESERVOIR, AND CYLINDER.

Plate A4 shows the arrangement of the triple valve, reservoir, and brake-cylinder, from which the operation of the former will be more clearly understood than from a section of the triple valve alone.

The triple valve has a piston, 5, working in the chamber B, and carrying with it a slide-valve, 6. Air enters from the main pipe through the four-way cock 13 into the drain-cup A, and passes to the chamber B, forcing the piston up, and uncovering a small feeding-groove in the upper part of the chamber, which permits air to flow past the piston into the auxiliary reservoir, while, at the same time, there is an open communication from the brake-cylinder to the atmosphere, through the passages *d*, *e*, *f*, and *g*. Air will continue to flow into the auxiliary reservoir until it contains the same pressure as the main brake-pipe.

To apply the brakes with their full force, the compressed air in the main brake-pipe is allowed to escape, when the greater pressure in the auxiliary reservoir forces the piston 5 down below the feeding-groove, thus preventing the return of air from the reservoir to the brake-pipe. As the piston descends, it moves with it the slide-valve 6, so as to permit air to flow directly from the auxiliary reservoir into the brake-cylinder, which forces the pistons out and applies the brakes. The brakes are released by again admitting pressure into the main brake-pipe from the main reservoir, which pressure, being greater than that in the auxiliary reservoir, forces the piston 5 back to the position shown in the drawing, recharges the reservoir, and at the same time permits the air in the brake-cylinders to escape. To apply the brakes gently, a slight reduction is made in the pressure in the main brake-pipe, which moves the piston down slowly until it is stopped by the graduating

spring 9; at this point the opening *l* in the slide-valve is opposite the port *f*, and allows air from the auxiliary reservoir to feed through a hole in the side of the slide-valve and through the opening *l* into the brake-cylinder. The passage *l* is opened and closed by a small valve, 7, which is attached to and moves with the piston 5, provision being made for a limited motion of these parts without moving the valve 6. When the pressure in the auxiliary reservoir has been reduced by expanding into the brake-cylinder until it is the same as the pressure in the main brake-pipe, the graduating spring pushes the piston up until the small valve, 7, closes the feed opening, *l*. This causes whatever pressure is in the brake-cylinder to be retained, thus applying the brakes with a force proportionate to the reduction of pressure in the brake-pipe.

To prevent the application of the brakes from a slight reduction of pressure caused by leakage in the brake-pipe, a semicircular groove is cut in the body of the car-cylinder, nine sixty-fourths of an inch in width and five sixty-fourths of an inch in depth, and extending so that the piston must travel three inches before the groove is covered by the packing leather. A small quantity of air, such as results from a leak, passing from the triple valve into the car-cylinder, has the effect of moving the piston slightly forward, but not sufficiently to close the groove, which permits the air to flow out past the piston. If, however, the brakes are applied in the usual manner, the piston will be moved forward, notwithstanding the slight leak, and will cover the groove. It is very important that the groove shall be three inches long, and shall not exceed in area the dimensions given above. Heretofore we have used leakage valves, and have also had a leakage hole. These leakage holes we have found to be too uncertain in their operation, and we consequently recommend that these holes should be closed, and the grooves in the cylinders substituted as rapidly as possible. We furnish a special machine for cutting the groove, if desired, at a low price.

When the handle of the four-way cock, 13, is turned down, there is a direct communication from the main brake-pipe to the brake-cylinder, the triple valve and auxiliary reservoir being cut out, and the apparatus can then be worked as a non-automatic brake by admitting the air into the main brake-pipe and brake-cylinder to apply the brakes. When, from any cause,

it is desirable to have the brake inoperative on any particular car, the four-way cock is turned to an intermediate position, which shuts off the brake-cylinder and reservoir, leaving the main brake-pipe unobstructed to supply air to the remaining vehicles.

The drain-cup A collects any moisture that may accumulate, and is drained by unscrewing the bottom nut.

Plate A5 shows the various parts used to form complete sets of brake apparatus for either the automatic or the non-automatic system, a number of these parts being illustrated in detail in subsequent sheets. This company furnishes all brake apparatus in accordance with the terms and prices stated in the form of agreement printed herewith, and this plate shows all the articles enumerated in the various schedules of the agreement, as well as a few special parts used in exceptional cases.

DETAILS OF BRAKE APPARATUS.

PLATE A5.

No.	
1.	Main Reservoir.
2.	Auxiliary Reservoir (12 by 33 in.).
3.	Auxiliary Reservoir (10 by 24 in.).
4.	Standard Air-pump.
5.	Eight-inch Air-pump.
6.	Narrow-gauge Air-pump.
7.	Narrow-gauge Car-cylinder.
8.	Tender Cylinder.
9.	Standard Car-cylinder.
10.	Standard Driving-wheel Brake-cylinder.
11.	Narrow-gauge Driving-wheel Brake-cylinder.
12.	Engineer's Brake-valve.
13.	Three-way Cock.
14.	Air-gauge.
15.	Automatic Lubricator.
16.	Three-quarter inch Stop-cock.
17.	Pump Regulator.
18.	Steam Valve.
19.	Pump Drain-cock.
20.	Air-cylinder Oil-cup.
21.	Conductor's Valve.
22.	Triple Valve.
23.	Triple Valve, with Brass Case.
24.	Cylinder Release Cock.
25.	Air-pipe Strainer.
26.	Tender Drain-cup.
27.	Car Drain-cup.
28.	Triple Valve Bracket.
29.	Double Check-valve.
30.	Three-quarter inch Reservoir Union.
31.	One-inch Reservoir Union.
32.	Discharge-valve Seat Wrench.
33.	Auxiliary Brake-valve.
34.	One-inch Malleable Union.
35.	Three-quarter inch Malleable Union.
36.	One-half inch Malleable Union.
37.	One-quarter inch Malleable Union.
38.	Three-quarter inch by one-half inch T.
39.	One-half inch T.
40.	One-half inch by three-eighth inch T.

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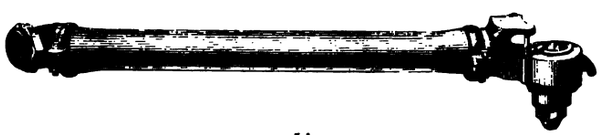
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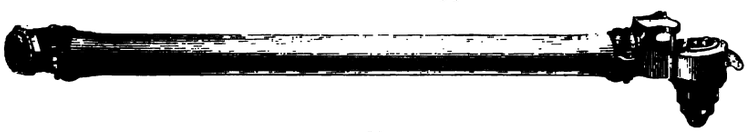
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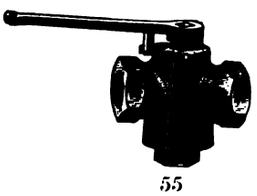
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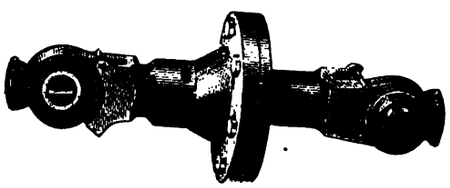
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DETAILS OF BRAKE APPARATUS—CONTINUED.

PLATE A5.

No.
41. Half-inch by quarter-inch T.
42. One-inch L.
43. Three-quarter inch L.
44. One-half inch L.
45. One-quarter inch L.
46. One-half inch Nipple.
47. Three-quarter inch Nipple.
48. Coupling-valve Key.
49. Cap-screw Wrench.

No.
50. Packing-nut Wrench.
51. Hose and Coupling, Narrow-gauge.
52. Hose and Coupling, Standard.
53. Driving-wheel Brake Hose.
54. Tender Hose.
55. One-inch Cock.
56. Auxiliary Discharge-valve.

[AGREEMENT.]

WHEREAS, THE WESTINGHOUSE AIR-BRAKE COMPANY, of the City of Pittsburgh, Pennsylvania, operating under sundry Letters Patent of the United States, some of which are owned or controlled by the said Company, and others of which are owned by George Westinghouse, Jr., of said city, as patentee, is engaged in making and selling apparatus for operating railway car brakes by compressed air, which apparatus, as adapted for use on the different parts of a railway train, or as employed on trains in different modes of operation, is for convenience classified as per the following schedules:

Schedule A (constituting the equipment of a locomotive in the system of brake apparatus heretofore in use as the Westinghouse Air-Brake): One Steam Engine and Pump, One Main Air Reservoir, One Air-gauge, One Three-way Cock, One one-and-three-quarter inch Lubricator, One Oil-cup for Air-pump, One Steam-cock, One Drain-cock, One Safety-valve, One Air-pipe Strainer, Hose and Couplings with Valves, One three-feet Hose Connection, one hundred and twenty-five feet of Pipe, assorted sizes, Thirty Pipe Fittings, assorted, Three Wrenches.

Schedule B (constituting the equipment of a tender in the same system): One eight-inch Air-brake Cylinder complete, with sleeve.

Schedule C (constituting the equipment of a passenger car in the same system): One ten-inch Air-brake Cylinder complete, with Releasing Springs, Hose and Couplings with Valves complete, one hundred and thirty feet of Pipe, assorted sizes, Thirteen Pipe Fittings, assorted.

Schedule D (being the additional apparatus provided for equipping a locomotive-driver brake in the same or AUTOMATIC system): Two eight-inch Air-brake Cylinders, Thirty feet half-inch Pipe, Six Pipe Fittings, assorted, One Check-valve, One Safety-valve.

Schedule E (constituting the equipment of a locomotive in the Westinghouse AUTOMATIC system): Same as "Schedule A," for "Hose and Couplings *with* Valves," substituting "Hose and Couplings *without* Valves," and one Stop-cock.

Schedule F (constituting the equipment for a tender in the AUTOMATIC system): One eight-inch Air-brake Cylinder complete, with Releasing Cock, One Triple Valve, with Nipple and Bracket, One Auxiliary Air Reservoir, One Drain Cup and Cock, ten feet half-inch Pipe, Six Pipe Fittings, assorted.

Schedule G (constituting the equipment for a passenger car in the AUTOMATIC system): One ten-inch Cylinder, as in "Schedule C," with Releasing Cock, One Auxiliary Air Reservoir, One Drain Cup, One Triple Valve, with Nipple and Bracket, One Conductor's Valve, Hose and Couplings without Valves, Two Stop-cocks, seventy-five feet Pipe, Twelve Pipe Fittings, assorted.

Schedule V (being the apparatus provided as additional to that mentioned in "Schedules A and B," for equipping a locomotive and tender to work both the "old" and "automatic" systems): One Auxiliary Air Reservoir, One Triple Valve, Hose and Couplings, ten feet half-inch Pipe, thirty feet three-quarter inch Pipe, Five Pipe Fittings, assorted.

Schedule W (being the apparatus provided as additional to that mentioned in "Schedule C," for a passenger train under both the "old" and "automatic" systems): One Auxiliary Air Reservoir, One Triple Valve, One Conductor's Valve, One Double Check-valve, One Drain Cup, Hose and Couplings without Valves, eighty feet of Pipe, assorted sizes, Twelve Pipe Fittings, assorted.

Schedule X (being apparatus required to change a passenger car from the "old" to the "automatic" system): One Auxiliary Air Reservoir with Drain Cock, One Triple Valve, One Conductor's Valve, One Drain Cup, Hose and Couplings. (Pipe of old brake can be utilized.)

Schedule Y (constituting a brake equipment complete for a locomotive and tender in the "old" system): The articles named in Schedules A, B, and D, when ordered together.

Schedule Z (constituting a brake equipment complete for a locomotive and tender in the AUTOMATIC system): The articles named in Schedules E, F, and D, when ordered together.

And Whereas, the.....Company, a Corporation duly authorized under the laws of the State of..... ....and operating what is known as the..... .... is desirous of introducing some or all the apparatus named in said schedules into use on its said road.

Now these presents witness, That the said "WESTINGHOUSE AIR-BRAKE COMPANY," party of the first part hereto, and the said GEORGE WESTINGHOUSE, Jr., party of the second part hereto, and the said..... ....Company, party of the third part hereto, for the considerations hereinafter named, have covenanted and agreed, and do hereby covenant and agree, to and with each other, as follows, to wit:

1st. That the said party of the first part will, within a reasonable time after the proper order or orders therefor are received, sell and deliver, well made and in good order and condition, to said party of the third part, such sets and such number of sets of the said apparatus (the articles designated in any one of the foregoing schedules constituting a set) as may be ordered from time to time, at a rate not to exceed for each schedule set the prices to such schedules herewith respectively annexed, as follows:

Schedule A.—Three Hundred Dollars.
" *B.*—Twenty-five Dollars.
" *C.*—One Hundred Dollars.
" *D.*—Fifty Dollars.
" *E.*—Three Hundred Dollars.
" *F.*—Sixty Dollars.
" *G.*—One Hundred and Thirty-eight Dollars.

Schedule V.—Thirty-five Dollars.
" *W.*—Eighty-eight Dollars.
" *X.*—Eighty Dollars.
" *Y.*—Three Hundred and Twenty-five Dollars.
" *Z.*—Three Hundred and Sixty Dollars.

Which prices are for sets so purchased, and when paid for, inclusive of license fee or royalty for the use thereof, complete and unbroken, on the locomotive, tender, or car to which they may be applied; but the license to use shall not be complete and effectual to protect the purchaser or other subsequent possessor of such apparatus in the use thereof until the said prices are fully paid. The said schedules shall be subject to change or variation as, and only as, the articles designated therein may by further improvement be rendered practically useless, or as, by further improvement,

other devices of like function may be provided as substitutes for those named, but such changes or variations shall not cause any change in the prices of the schedule sets, as above given.

Delivery in all cases to be made at the depot, wharf, or other designated place of shipment or consignment in the city of Pittsburgh.

2d. That the said party of the first part, within like reasonable time, will sell, and in like manner deliver, to said party of the third part, such parts or pieces, or separate detached portions of the apparatus named in the foregoing schedules, as may be required for renewals and ordinary repairs in previously purchased complete sets of the said apparatus, charging therefor the reasonable manufacturers' price for making the same, and without other or additional license fee or royalty.

3d. That the said party of the third part shall make and keep a correct record, open at all reasonable times to the inspection of said party of the first part, or its duly authorized officer or agent, of all cars, locomotives, and tenders owned or leased by it and equipped with air-brake apparatus; which record shall contain and show all additions to the said equipment, by new sets applied, or by the purchase or lease of rolling stock already so equipped, and from whom purchased or leased, as also the reductions of such equipment by sale or lease of rolling stock already equipped, and to whom sold or leased; but the said party of the third part shall not order, for the purpose of selling, leasing, or otherwise disposing of, to others, any part or parts of sets, nor a whole set, except in connection with the car, tender, or locomotive to which it may be applied, nor shall it use any part or parts of sets otherwise than in renewing or repairing the lost, broken, or worn-out parts of complete sets previously bought and paid for.

4th. That in case the said party of the first part should at any time hereafter become possessed of, own, or control any other patent or patents for further IMPROVEMENTS in the construction of the devices named in said schedules, which improvements the said party of the third part may be desirous of using, the said party of the first part shall sell and deliver to said party of the third part, in like manner, for like use and subject to like conditions, as aforesaid, on proper orders received, the devices so improved, at the reasonable manufacturers' price for making the same, without other or additional license fee or royalty except such as will reasonably remunerate the said party of the first part for actual outlay in the purchase of the patents for said improvements.

5th. That on the delivery as aforesaid of any of the apparatus hereinbefore referred to, the said party of the third part will pay to said party of the first part the price thereof, as fixed or stipulated to be fixed by the foregoing provisions.

6th. That the said party of the first part, in order to secure and preserve complete uniformity in all parts of the said apparatus as used on different, though connecting, railway lines, hereby expressly reserves to itself a right, exercisable at its own option, to furnish to said party of the third part, ready for use, but free of cost, any or all parts of said apparatus of substantially the same construction as that previously furnished, and differing only in form or dimensions, which apparatus, so furnished, the said party of the third part, in furtherance of the same object, shall and does hereby agree thereafter to apply and use, to the exclusion of the like devices for which they may be designed as a substitute; and for the same purpose, the said party of the first part also reserves the right to make and furnish, at reasonable manufacturers' price, and deliverable in the manner aforesaid, all Couplings, Leakage Valves, Double Check-valves and Triple Valves, and each and every part thereof with which the said party of the third part may desire to renew or replace the corresponding devices or parts on the same car, tender, or locomotive, worn out, broken, or lost.

7th. In case the said party of the first part should at any time grant any reduction in prices above named, or any right or license to any railway company or corporation to manufacture and sell, for railway car-brake purposes, any or all the patented improvements named in said schedules, then the said party of the third part shall be entitled to a like reduction for a like consideration, and a like right and license on like terms, considerations, and conditions; but nothing herein contained shall be so construed as to prevent the said party of the third part from making all necessary repairs to the apparatus purchased of the said party of the first part as hereinbefore provided, or of any part thereof, except as mentioned in paragraph 6th, above.

8th. That the said party of the first part will indemnify and save harmless the said party of the third part from all necessary or proper costs, expense, or damages incurred by reason of any suit or suits against the said party of the third part for any alleged infringement of any other letters-patent, which alleged infringement shall consist in the use of the apparatus furnished to said party of the third part under the foregoing provisions, provided that the said party of the first part shall first have written notice of such suit or suits, and be allowed the opportunity of defending the same.

9th. That the said party of the third part shall have the right to run locomotives, tenders, and cars, fitted up with air-brake apparatus purchased from the said party of the first part as hereinbefore provided, over or on any connecting line of railway, or any railway line owned, leased, or controlled by them, without the payment of other or additional consideration therefor; provided, however, that nothing herein contained shall be construed as authorizing the use of any of the apparatus named in the above schedules in combination with steam or air brake apparatus not made by or under license from the parties of the first and second parts.

To a due and faithful compliance with the covenants and agreements hereinbefore contained, the said parties of the first, second, and third parts do hereby bind themselves, their legal representatives, successors, and assigns, each to the other, and his or their legal representatives, successors, and assigns.

In Witness Whereof, The said parties of the first and third parts have caused their corporate seals to be hereunto affixed, attested by the hands of the Presidents and Secretaries of the said respective Corporations, and the said party of the second part has hereunto set his hand and seal this..... .....day of.....A. D. 188

.... [L. S.]

....
President Westinghouse Air-Brake Company.

Attest:

....
Secretary Westinghouse Air-Brake Company.

....

President..... .....Company.

Attest:

.....

Secretary..... .....Company.

DETAILS OF STANDARD PUMP.

PLATE A6.

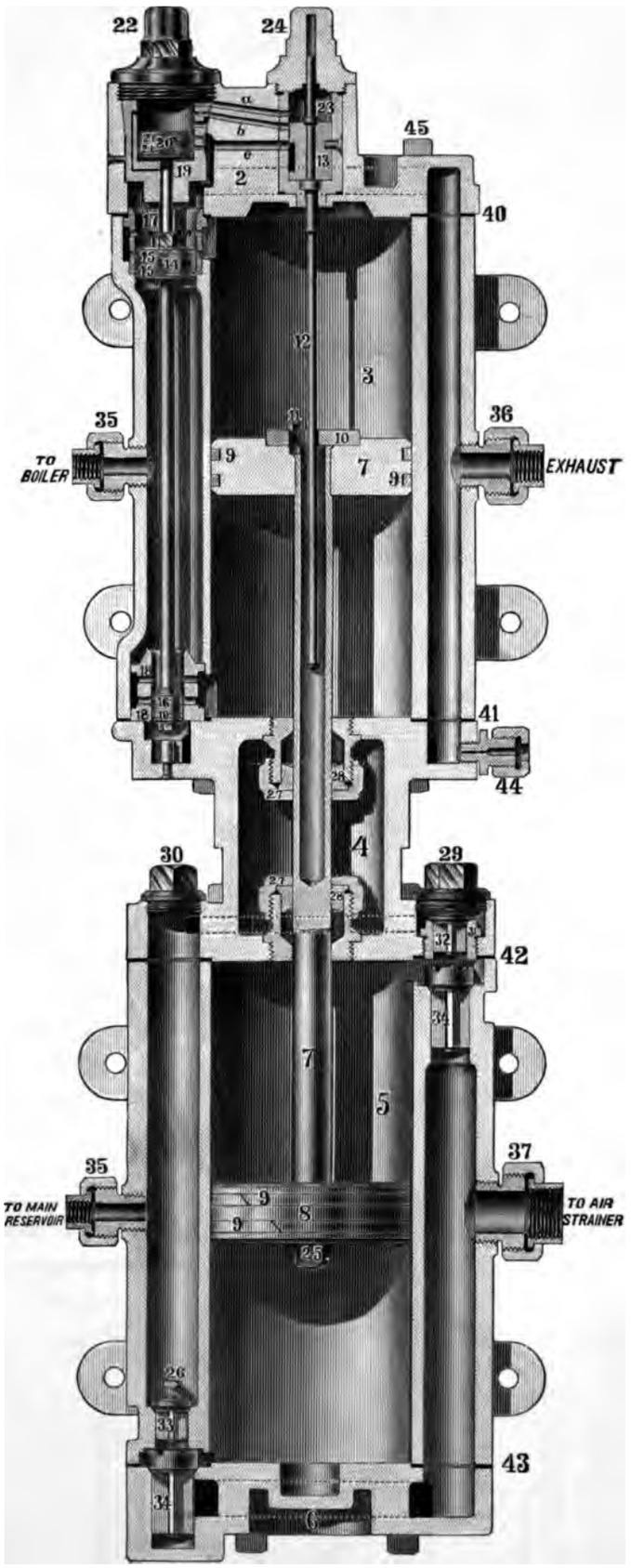
No.
1. Engine and Pump, complete. (No. 4, Plate A5.)
2. Steam-cylinder Head (with Reversing-cylinder, Piston and Valve Bushes).
3. Steam-cylinder (with Main Valve and Bushes).
4. Center-piece.
5. Air-cylinder (with Lower Discharge-valve).
6. Air-cylinder Head.
7. Steam-piston and Rod.
8. Air-piston.
9. Main Piston Packing-ring.
10. Reversing-valve Plate.
11. Reversing-valve Plate Bolt.
12. Reversing-valve Stem.
13. Reversing-valve.
14. Main Steam-valve.
15. Packing-ring for Upper Piston-valve.
16. Packing-ring for Lower Piston-valve.
17. Upper Main Steam-valve Bush.

No.
18. Lower Main Steam-valve Bush.
19. Reversing-cylinder.
20. Reversing-piston.
21. Reversing-piston Packing-ring.
22. Reversing-cylinder Cap.
23. Reversing-valve Bush.
24. Reversing-valve Cap.
25. Piston-rod Nut.
26. Discharge-valve Stop-bolt.
27. Piston-packing Nut.
28. Piston-packing Gland.
29. Right Chamber Cap.
30. Left Chamber Cap.
31. Discharge-valve Seat.
32. Upper Discharge-valve.
33. Lower Discharge-valve.
34. Receiving-valve.
35. Half-inch Union.
36. Three-quarter-inch Union.
37. One-inch Union.
40. Top Steam-cylinder Gasket.
41. Bottom Steam-cylinder Gasket.
42. Top Air-cylinder Gasket.
43. Bottom Air-cylinder Gasket.

In ordering detached parts for repairs, please specify the plate and the number of each piece accurately, to avoid errors.

STANDARD AIR-PUMP.

PLATE A6.



STANDARD AIR-PUMP.

Plate A6 shows the pump that has been most extensively used in standard gauge equipment, and this style is invariably furnished except when some one of the other designs illustrated herewith is designated.

The steam from the boiler enters the top cylinder between two pistons forming the main valve 14. The upper piston being of greater diameter than the lower, the tendency of the pressure is to raise the valve, unless it is held down by the pressure of a third piston, 20, of still greater diameter, working in a cylinder directly above the main valve.

The pressure on this third piston is regulated by the small slide-valve 13, working in the central chamber on the top head. This valve receives its motion from a rod, 12, extending into the hollow piston, which, as shown in the drawing, has a knob at its lower end and a shoulder just below the top head. This valve chamber in the top head, by a suitable steam-port, is constantly in communication with the steam space between the two pistons of the main valve. The steam acting on the third piston, 20, and holding the main valve down, enters below the main piston; as the main piston approaches the upper head, the reversing-valve rod, 12, and its valve, 13, are raised until the slide-valve exhausts the steam from the space above the third or reversing piston, when the main valve is raised by the steam pressure on the greater area of its upper piston, which movement of the main valve admits steam to the upper end of the main cylinder.

When the main valve is moved up to admit steam to the upper end of the cylinder, it opens an exhaust-port at the lower end, just below the lower steam-port, which latter is closed by the lower piston of the main valve; and when the main piston is on its upward stroke, the upper exhaust-port is similarly opened. The air-valves of the pump are similar to those used in all pumps. The lift of a discharge valve should not exceed one-sixteenth of an inch.

EIGHT-INCH AIR-PUMP.

Plate A7 shows a pump designed especially for use in freight service, as it furnishes a large volume of air in a short time. The operation is the same as that of the pump shown on Plate A6, and no further explanation is necessary.

DETAILS OF EIGHT-INCH AIR-PUMP.

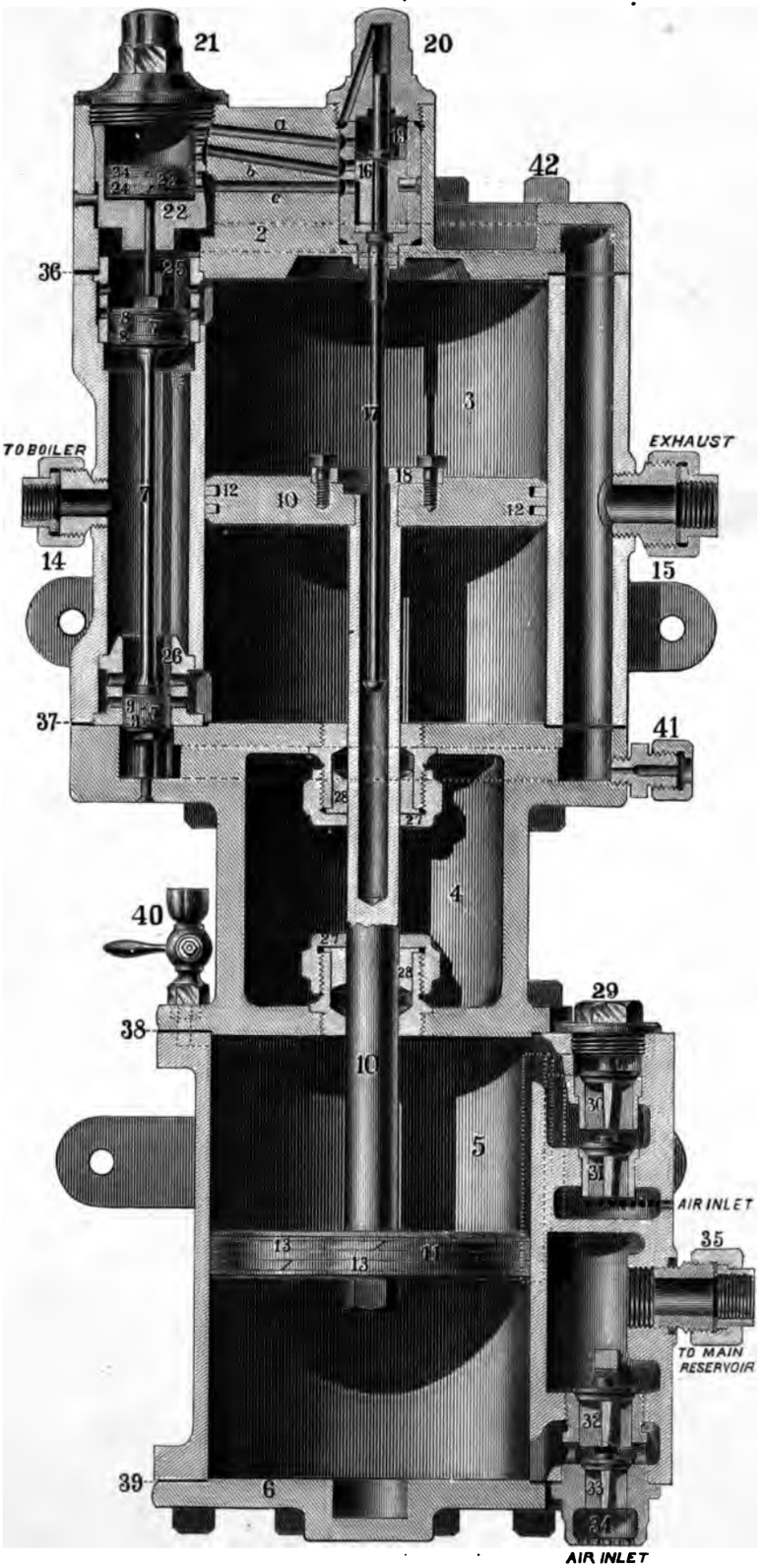
PLATE A7.

No.	
1.	Eight-inch Pump, complete. (No. 5, Plate A5.)
2.	Top Head, with Reversing-cylinder, Piston and Valve Bushes.
3.	Steam-cylinder, with Main Valve and Bushes.
4.	Center-piece.
5.	Air-cylinder Body, with Valves.
6.	Air-cylinder Head.
7.	Main Valve.
8.	Upper Main Valve Packing-ring.
9.	Lower Main Valve Packing-ring.
10.	Steam Piston and Rod.
11.	Air-piston.
12.	Steam-piston Packing-ring.
13.	Air-piston Packing-ring.
14.	Steam-pipe Union.
15.	Exhaust-pipe Union.
16.	Reversing-valve.
17.	Reversing-valve Stem.
18.	Reversing-valve Plate.
19.	Reversing-valve Bush.
20.	Reversing-valve Chamber Cap.
21.	Reversing-cylinder Cap.
22.	Reversing-cylinder.
23.	Reversing-piston.
24.	Reversing-piston Packing-ring.
25.	Upper Main Valve Bush.
26.	Lower Main Valve Bush.
27.	Packing-nut.
28.	Packing-gland.
29.	Upper-valve Chamber Cap.
30.	Upper Discharge-valve.
31.	Upper Receiving-valve.
32.	Lower Discharge-valve.
33.	Lower Receiving-valve.
34.	Lower-valve Chamber Cap.
35.	Reservoir Union.
36.	Upper Steam-cylinder Gasket.
37.	Lower Steam-cylinder Gasket.
38.	Upper Air-cylinder Gasket.
39.	Lower Air-cylinder Gasket.
40.	Air-cylinder Oil-cup.
41.	Drain-pipe Union.
42.	Cylinder-head Bolt.

In ordering detached parts for repairs, please specify the plate and number of each piece accurately, to avoid mistakes.

EIGHT-INCH AIR-PUMP.

PLATE A7.



NARROW-GAUGE AIR-PUMP.

Plate A8 shows the standard pump for narrow-gauge equipment, the construction and operation being the same as the standard pump, except that a different air-valve arrangement is used.

DETAILS OF NARROW-GAUGE PUMP.

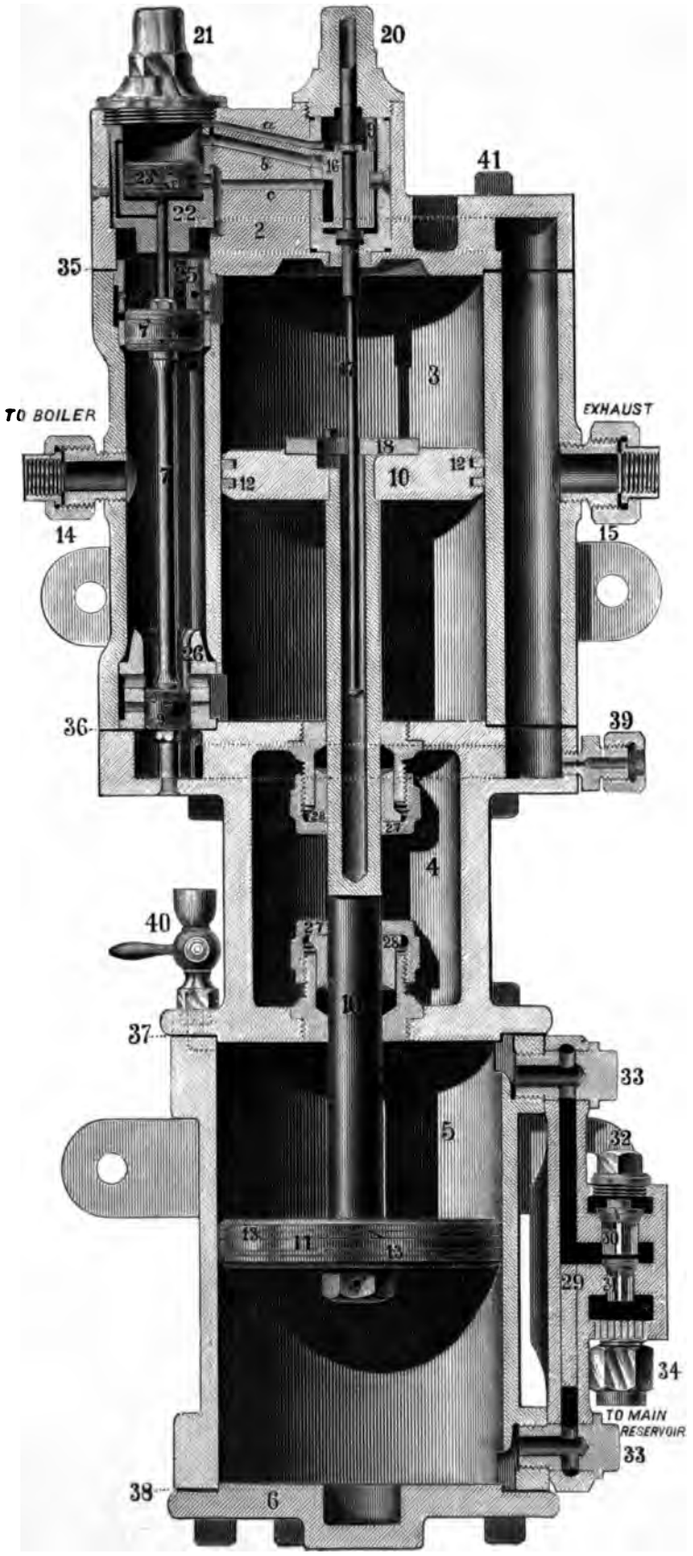
PLATE A8.

No.	
1.	Engine and Pump complete. (No. 6, Plate A5.)
2.	Steam-cylinder Head, with Reversing-cylinder, Piston, and Valve Bushes.
3.	Steam-cylinder, with Main Valve and Bushes.
4.	Center-piece.
5.	Air-cylinder.
6.	Air-cylinder Head.
7.	Main Steam-valve.
8.	Packing-ring for Upper Piston-valve.
9.	Packing-ring for Lower Piston-valve.
10.	Steam-piston and Rod.
11.	Air-piston.
12.	Steam-piston Packing-ring.
13.	Air-piston Packing-ring.
14.	Half-inch Union.
15.	Three-quarter-inch Union.
16.	Reversing-valve.
17.	Reversing-valve Stem.
18.	Reversing-valve Plate.
19.	Reversing-valve Bush.
20.	Reversing-valve Cap.
21.	Reversing-cylinder Cap.
22.	Reversing-cylinder.
23.	Reversing-piston.
24.	Reversing-piston Packing-ring.
25.	Upper Main Steam-valve Bush.
26.	Lower Main Steam-valve Bush.
27.	Piston-packing Nut.
28.	Piston-packing Gland.
29.	Air-valve Case.
30.	Discharge-valve.
31.	Receiving-valve.
32.	Valve-chamber Cap.
33.	Side-pipe Bolt.
34.	Air-discharge Pipe Union.
35.	Upper Steam-cylinder Gasket.
36.	Lower Steam-cylinder Gasket.
37.	Upper Air-cylinder Gasket.
38.	Lower Air-cylinder Gasket.
39.	Drain-pipe Union.
40.	Air-cylinder Oil-cup.
41.	Cylinder-head Bolt.

In ordering detached parts for repairs, please specify the plate and the number of each piece accurately, to avoid errors.

NARROW-GAUGE AIR-PUMP.

PLATE A8.



TRIPLE VALVE.

Plate A9 illustrates the standard triple valve with cast-iron case, lined with brass bushes. The operation of the triple valve is fully described in connection with Plate A4.

DETAILS OF TRIPLE VALVE.

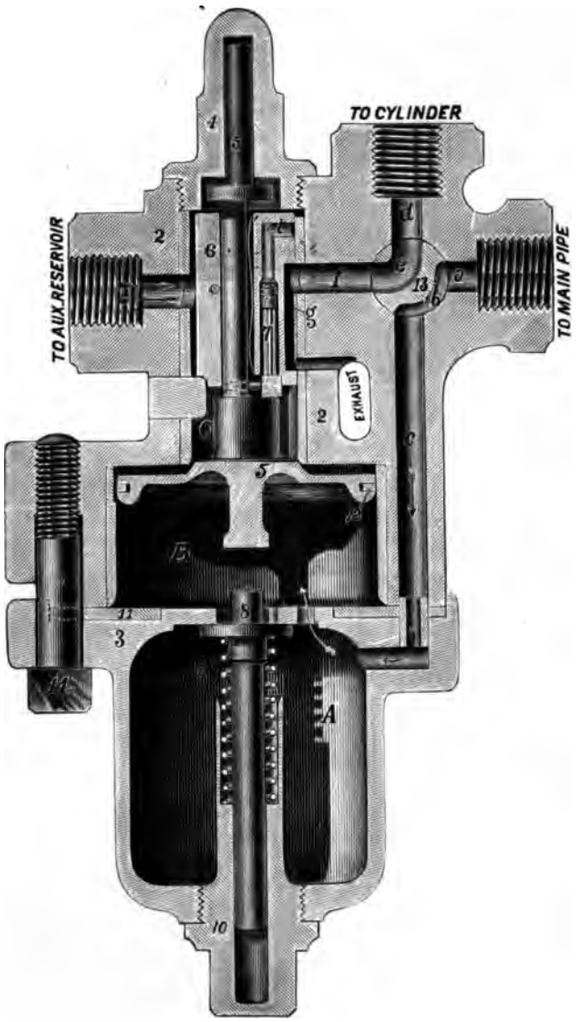
PLATE A9.

No.		No.	
1.	Triple Valve complete. (No. 22, Plate A5.)	8.	Graduating-stem.
2.	Triple-valve Case.	9.	Graduating-stem.
3.	Lower Cap.	10.	Bottom Nut.
4.	Upper Cap.	11.	Rubber Packing-ring.
5.	Piston.	12.	Piston Packing-ring.
6.	Slide-valve.	13.	Four-way Cock Plug.
7.	Graduating-valve.	14.	Bolt.

In ordering detached parts for repairs, please specify the plate and the number of each piece accurately, to avoid errors.

TRIPLE VALVE.

PLATE A9.



TRIPLE VALVE, WITH BRASS CASE.

Plate A10 shows a triple valve of the same general construction as the preceding one, but with brass case. The triple valves originally sent out can be altered to this internal arrangement, and are being so altered in large quantities. We recommend the use of the triple valve shown on Plate A9, as it is much stronger and less liable to damage. We furnish the style shown herewith only to roads who already have the greater part of their equipment fitted with the original triple valve, and desire uniformity in their pipe arrangement.

DETAILS OF TRIPLE VALVE, WITH BRASS CASE.

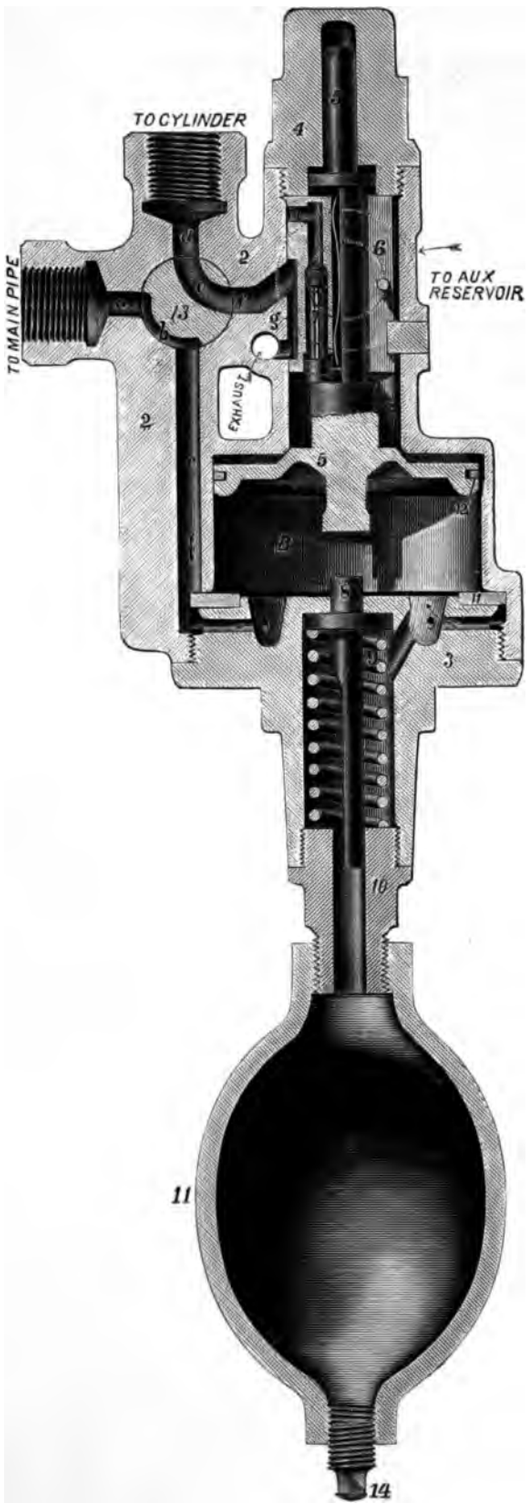
PLATE A10.

No.		No.	
1.	Triple Valve, with Brass Case complete. (No. 23, Plate A5.)	8.	Graduating-stem.
2.	Triple-valve Body.	9.	Graduating-spring.
3.	Lower Cap.	10.	Bottom Nut.
4.	Upper Cap.	11.	Drain-cup.
5.	Piston.	12.	Piston Packing-ring.
6.	Slide-valve.	13.	Four-way Cock Plug.
7.	Graduating-valve.	14.	Drain-cup Plug.

In ordering detached parts for repairs, please specify the plate and the number of each piece accurately, to avoid errors.

TRIPLE VALVE, WITH BRASS CASE.

PLATE A10.



DETAILS OF ENGINEER'S BRAKE-VALVE.

PLATE A11.

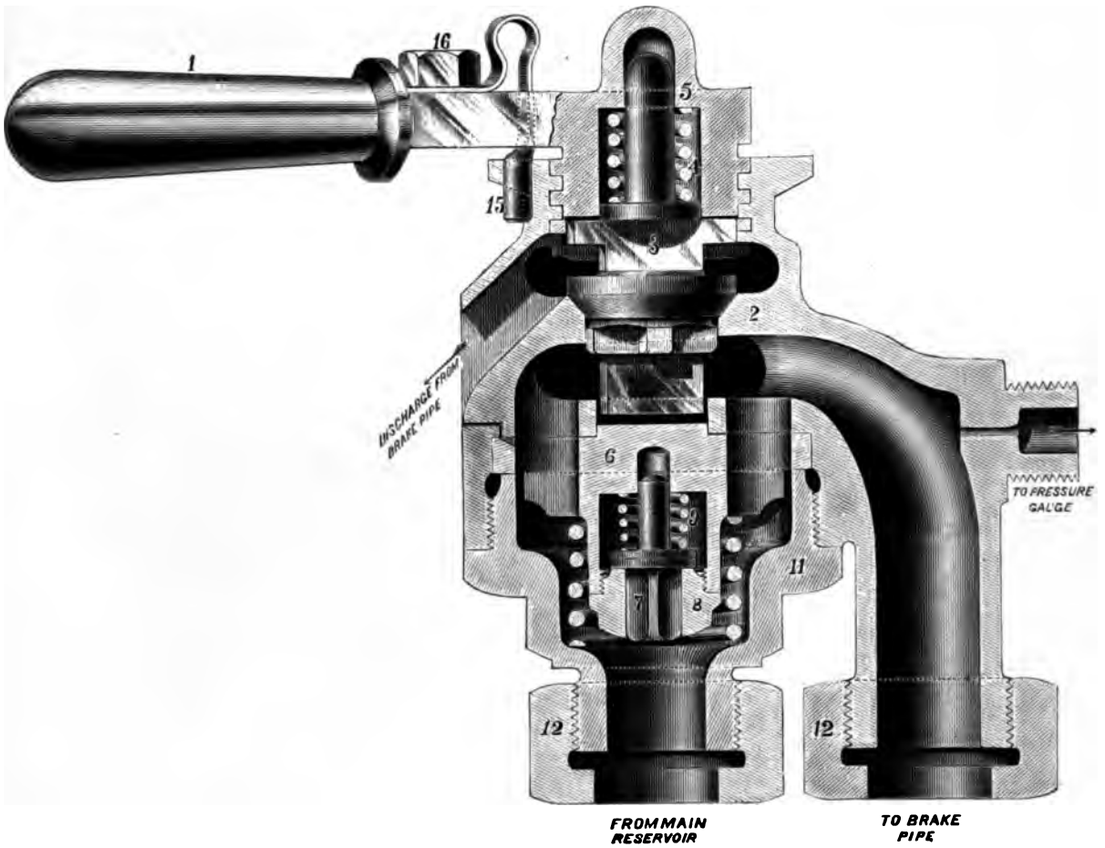
Engineer's Brake-Valve Complete, No. 12, Plate A5.

No.		No.	
1.	Handle.	9.	Feed-valve Spring.
2.	Body.	10.	Main-valve Spring.
3.	Top Valve.	11.	Lower Cap.
4.	Top-valve Spring.	12.	Union.
5.	Washer.	13.	Stud-nut (not shown).
6.	Main Valve.	14.	Gauge-pipe Nut (not shown).
7.	Feed-valve.	15.	Handle Spring.
8.	Feed-valve Seat.	16.	Handle-spring Nut.

In ordering detached parts for repairs, please specify the plate and the number of each piece accurately, to avoid errors.

ENGINEER'S BRAKE-VALVE.

PLATE A11.



ENGINEER'S BRAKE-VALVE.

Plate A11 shows the engineer's brake-valve, the handle of which terminates in a screw with a coarse thread, which compresses a spring, 4, upon the top valve, 3; this top valve fits into a slot in the handle 1, and into a slot in the main valve 6, so that the handle and the two valves must turn simultaneously. In the position shown in the drawing, which is for releasing the brakes, the top valve 3, leading to the atmosphere, is kept closed by the compression of the spring 4, and the air passes freely from the main reservoir to the brake-pipe, through the opening of the main valve and the body of the brake-valve. After the brakes are off, the handle is moved against the second stop a short distance to the right, which turns the main valve so that the main passages to the brake-pipe are closed. Air can, however, pass through the small valve 7, and thence to the brake-pipe through a small opening not shown in the drawing. This small valve 7 is held down by a spring whose resistance is equal to 20 pounds per square inch; hence the pressure in the main reservoir will always be 20 pounds greater than that in the brake-pipe, which surplus pressure insures the certain release of the brakes when desired. To apply the brakes, the handle is moved still farther to the right, when the opening from the small valve 7 is also closed, cutting off all communication from the main reservoir to the brake-pipe; at the same time the action of the screw lifts the handle and relieves the spring 4 from pressure, when the air in the brake-pipe lifts the valve 3, and escapes, until an equilibrium is established between the air-pressure and the pressure of the spring on the valve 3, thus reducing the pressure in the brake-pipe to an extent corresponding to the distance which the handle is moved.

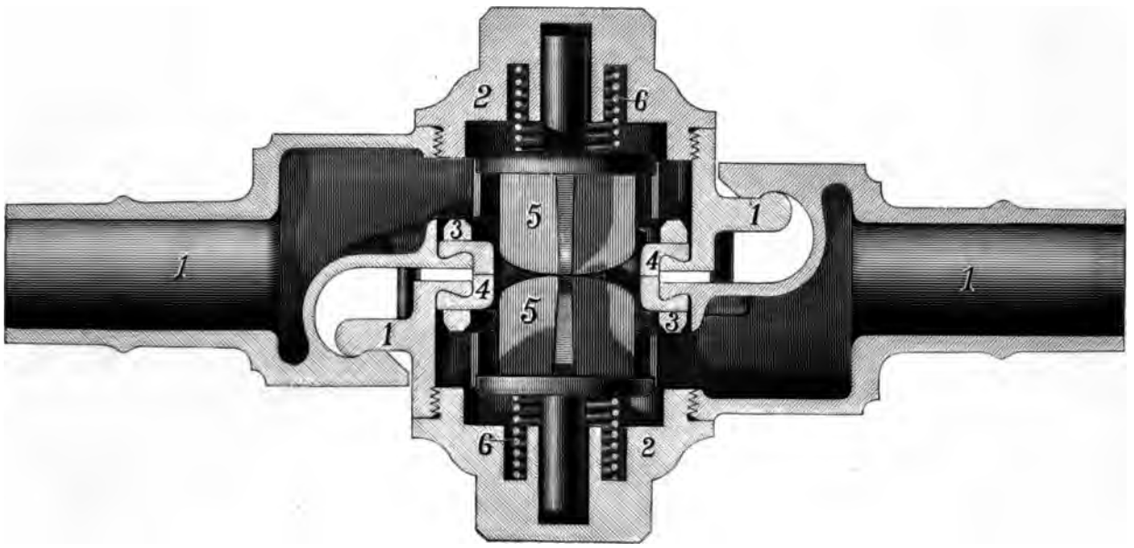
To apply the brakes suddenly, the handle is turned the entire distance to the right, which relieves the spring of all compression, allowing the valve 3 to rise, and all of the air in the brake-pipe to escape.

After the train is stopped, the brakes are released by turning the handle to the position shown in the drawing.

COUPLING WITH VALVES.

Plate A12 shows the style of coupling used in connection with the non-automatic system. The valves 5 are opened when the couplings are united, but close when they are disconnected, and prevent the escape of whatever pressure may be in the brake-pipe.

PLATE A12.



DETAILS OF COUPLING WITH VALVES.

PLATE A12.

Coupling with Hose and Nipple, complete. No. 51, Plate A5.

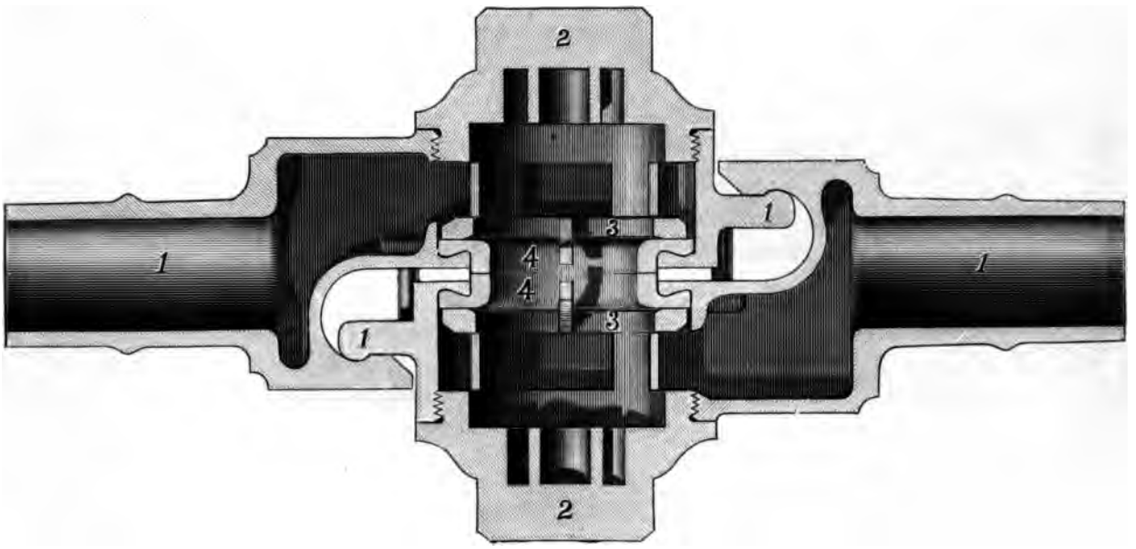
No.	No.
1. Coupling-case.	4. Coupling Packing-ring.
2. Coupling-cap.	5. Coupling-valve.
3. Packing-ring Washer.	6. Coupling-valve Spring.

In ordering detached parts for repairs, please specify the plate and the number of each piece accurately, to avoid errors.

COUPLING WITHOUT VALVES.

Plate A13 shows the coupling used with the automatic brake, which is the same as that shown on the preceding page, except that the valves and springs are omitted.

PLATE A13.



DETAILS OF COUPLING WITHOUT VALVES.

PLATE A13.

Coupling with Hose and Nipple, complete. No. 51, Plate A5.

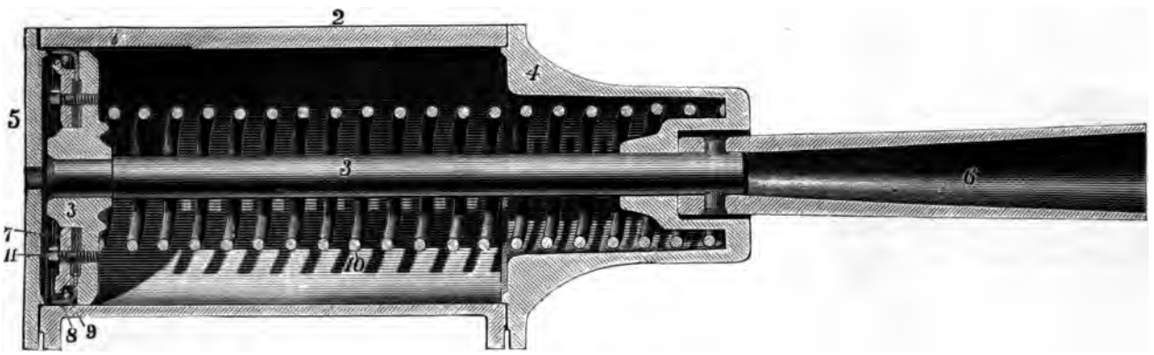
No.	
1. Coupling-case.	3. Packing-ring Washer.
2. Coupling-cap.	4. Packing-ring.

In ordering detached parts for repairs, please specify the plate and the number of each piece accurately, to avoid errors.

TENDER CYLINDER.

Plate A14 shows the brake-cylinder designed for use on tenders, the construction of which is so clearly shown by the drawing that no further explanation is necessary.

PLATE A14.



DETAILS OF TENDER CYLINDER.

PLATE A14.

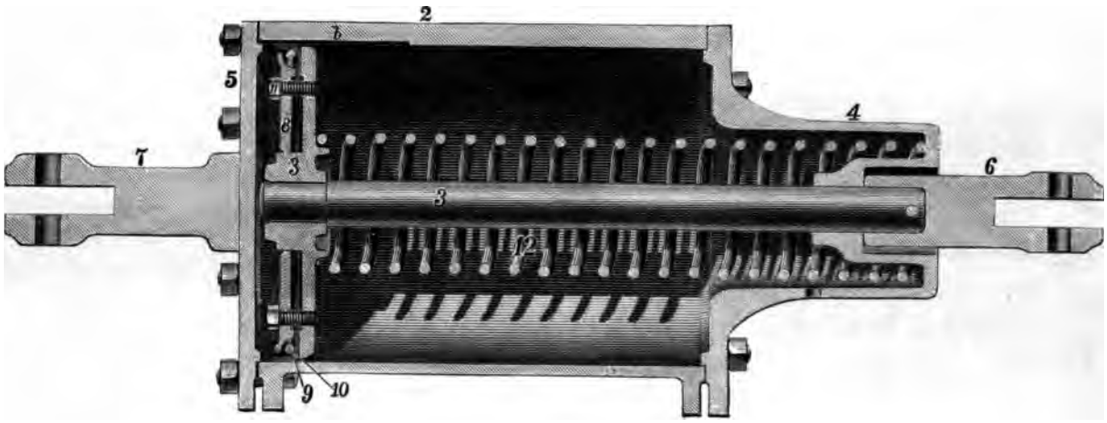
No.		No.	
1.	Tender Cylinder complete. (No. 8, Plate A5.)	6.	Piston-sleeve.
2.	Cylinder Body.	7.	Piston-follower.
3.	Piston and Rod.	8.	Piston Packing-leather.
4.	Back Head.	9.	Packing-leather Expander.
5.	Front Head.	10.	Release-spring.
		11.	Piston-follower Bolt.

In ordering detached parts for repairs, please specify the plate and number of each piece accurately, to avoid errors.

STANDARD TEN-INCH CAR-CYLINDER.

Plate A15 shows the car-cylinder used on standard-gauge passenger cars, the construction of which will be understood from the drawing.

PLATE A15.



DETAILS OF STANDARD TEN-INCH CAR-CYLINDER.

PLATE A15.

No.

1. Ten-inch Car-cylinder complete. (No. 9, Plate A5.)
2. Cylinder Body.
3. Piston and Rod.
4. Back Cylinder-head.
5. Front Cylinder-head.
6. Cross Head.

No.

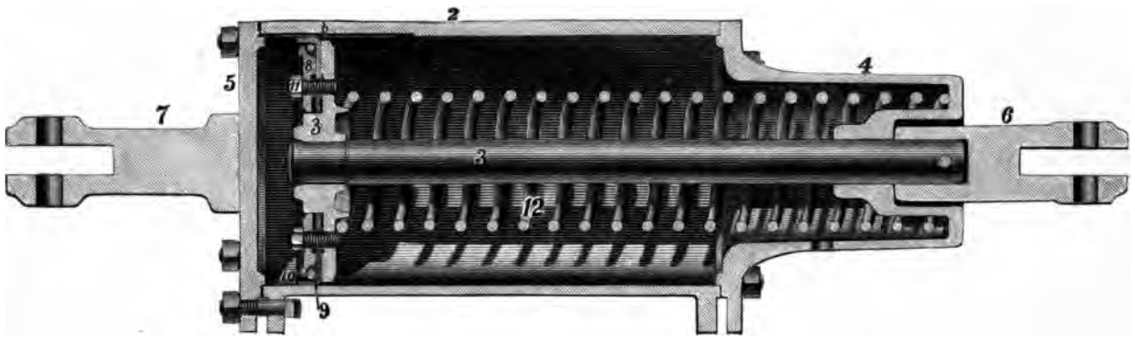
7. Lever-bracket.
8. Piston-follower.
9. Piston Packing-leather.
10. Packing-leather Expander.
11. Piston-follower Bolt.
12. Release-spring.

In ordering detached parts for repairs, please specify the plate and number of each piece accurately, to avoid errors.

EIGHT-INCH CAR-CYLINDER—NARROW GAUGE.

Plate A16 shows the eight-inch car-cylinder, which is used on narrow-gauge passenger cars.

PLATE A16.



DETAILS OF EIGHT-INCH CAR-CYLINDER—NARROW GAUGE.

PLATE A16.

No.		No.	
1.	Eight-inch Car-cylinder complete. (No. 7, Plate A5.)	7.	Lever-bracket.
2.	Cylinder Body.	8.	Piston-follower.
3.	Piston and Rod.	9.	Piston Packing-leather.
4.	Back Cylinder-head.	10.	Packing-leather Expander.
5.	Front Cylinder-head.	11.	Piston-follower Bolt.
6.	Cross Head.	12.	Release-spring.

In ordering detached parts for repairs, please specify the plate and number of each piece accurately, to avoid errors.

EIGHT-INCH BRAKE-CYLINDER, FOR DRIVING-WHEELS.

Plate A17 shows our standard eight-inch brake-cylinder for driving-wheels, the application of which will be clearly understood from the drawing. The air enters underneath the piston 3, and the cup-leather 7 makes an air-tight packing for the piston-rod.

DETAILS OF EIGHT-INCH BRAKE-CYLINDER FOR DRIVING-WHEELS.

PLATE A17.

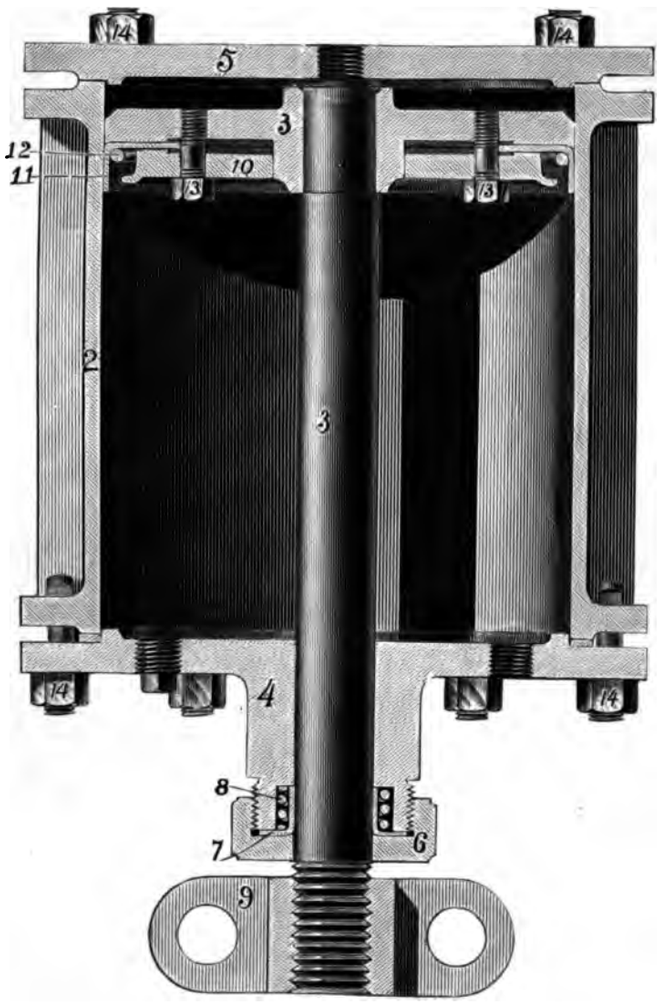
No.
1. Eight-inch Brake-cylinder for Driving-wheels, complete. (No. 10, Plate A5.)
2. Cylinder Body.
3. Piston and Rod.
4. Lower Head.
5. Upper Head.
6. Piston Rod Packing-nut.

No.
7. Piston Rod Cup-leather.
8. Piston Rod Packing-spring.
9. Cross Head.
10. Piston-follower.
11. Piston Packing-leather.
12. Piston Packing-expander.
13. Piston-follower Bolts.
14. Cylinder Bolts.

In ordering detached parts for repairs, please specify the plate and the number of each piece accurately, to avoid errors.

EIGHT-INCH BRAKE-CYLINDER FOR DRIVING-WHEELS.

PLATE A17.



SIX-INCH BRAKE-CYLINDER FOR DRIVING-WHEELS.

Plate A18 shows a six-inch brake-cylinder for driving-wheels, which is used on narrow-gauge engines. Its operation is the same as that of the standard cylinder, shown on Plate A17.

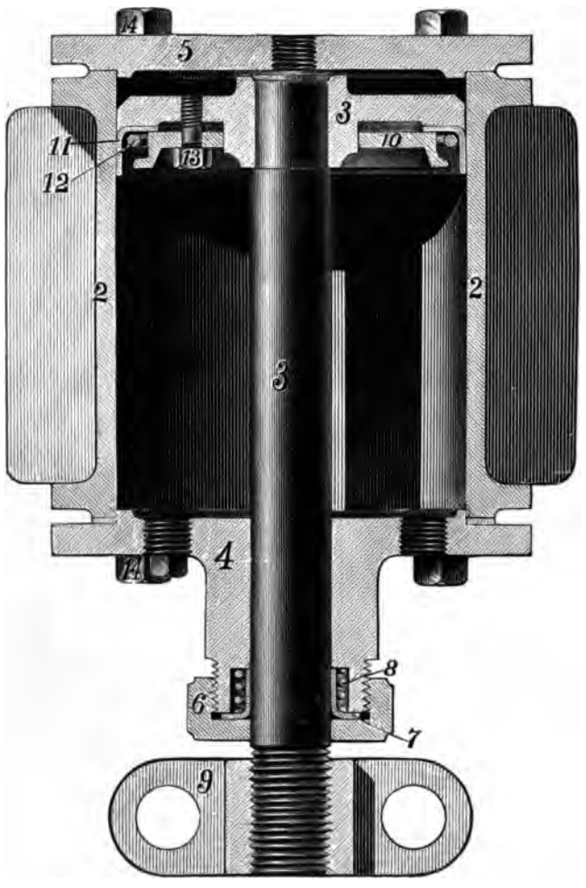
DETAILS OF SIX-INCH BRAKE-CYLINDER FOR DRIVING-WHEELS.

PLATE A18.

No.		No.	
1.	Six-inch Brake-cylinder for Driving-wheels, complete. (No. 11, Plate A5.)	7.	Piston Rod Cup-leather.
2.	Cylinder Body.	8.	Piston Rod Packing-spring.
3.	Piston and Rod.	9.	Cross Head.
4.	Lower Head.	10.	Piston-follower.
5.	Upper Head.	11.	Piston Packing-leather.
6.	Piston Rod Packing-nut.	12.	Packing-leather Expander.
		13.	Piston-follower Bolts.
		14.	Cylinder Bolts.

SIX-INCH BRAKE-CYLINDER FOR DRIVING-WHEELS.

PLATE A18.



DETAILS OF PUMP REGULATOR.

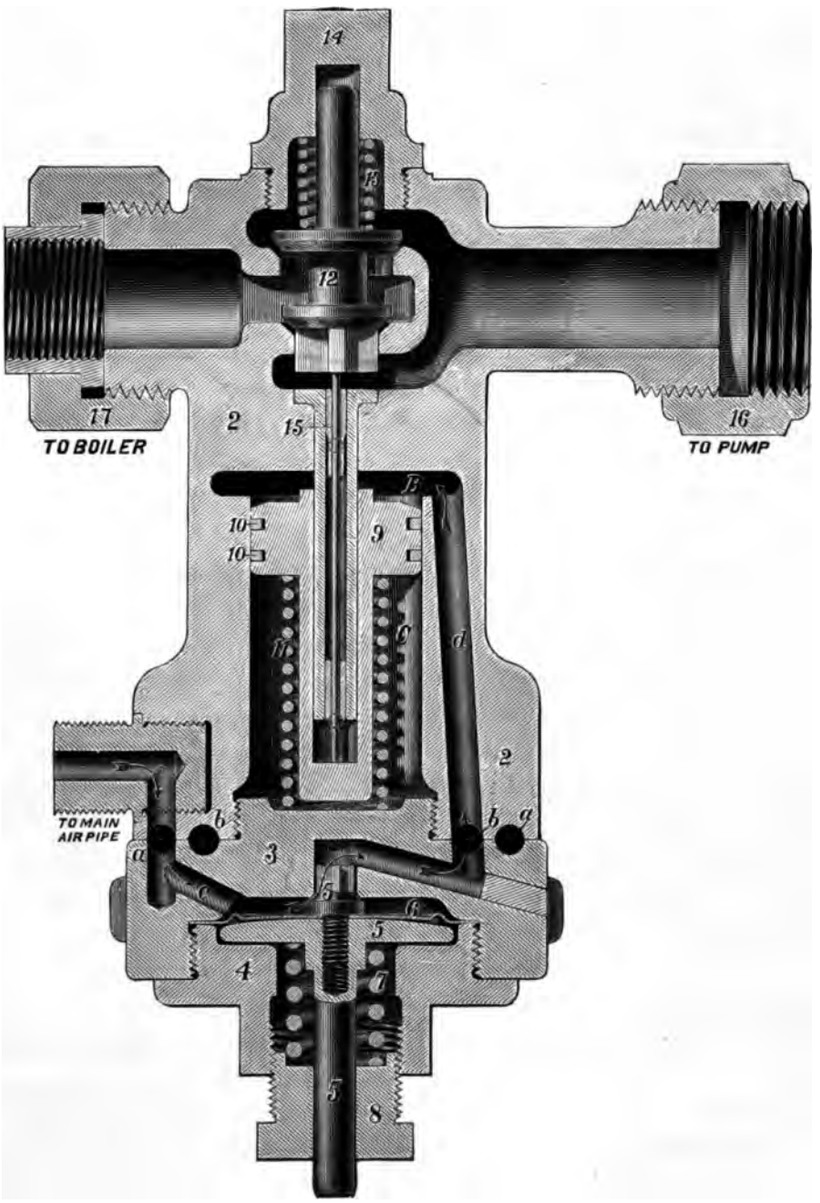
PLATE A19.

No.		No.	
1.	Pump Regulator, complete. (No. 17, Plate A5.)	9.	Piston.
2.	Regulator Body.	10.	Piston Packing-ring.
3.	Lower Head.	11.	Piston-spring.
4.	Lower Cap.	12.	Steam-valve.
5.	Lower Valve.	13.	Upper Spring.
6.	Diaphragm.	14.	Upper Cap.
7.	Regulating Spring.	15.	Valve-rod.
8.	Regulating Nut.	16.	Union Nut.

In ordering detached parts for repairs, please specify the plate and number of each piece accurately, to avoid errors.

PUMP REGULATOR.

PLATE A19.



PUMP REGULATOR.

Plate A19 illustrates a valve designed to automatically regulate the pressure of air in the brake-pipe. The steam from the boiler enters between the two discs of the balanced valve 12, which is held open by a small rod, 15, receiving its motion from a piston, which in turn is ordinarily held in its highest position by a spring, 11. On top of the valve, pushing in the contrary direction, is the spring 13, the resistance of which, however, is much less than that of the spring 11. A connection with the main air-pipe is made as indicated, and by a passage, *a*, air enters the chamber A above the diaphragm 6, which carries the valve 5. This valve 5 and the diaphragm are pressed upward by the strong spiral spring 7, the compression of which is regulated by the nut 8. When the pressure in the air-pipe and chamber A is sufficient to slightly open the valve 5, air then flows, as indicated by the passage *c* and *d*, to the chamber B above the piston 9; the pressure acting upon this piston compresses the spring 11, whereupon the steam-valve 12 is forced to its seat by the spring 13, and held in that position until the valve is again seated by the greater pressure of the spring 11. The pressure in the chamber B gradually leaks away past the piston, thus permitting the spring, by its action on the rod 15, to open the valves.

It will be seen from this that, when the pressure in the brake-pipe has reached a certain point, the pump will automatically be stopped, or so nearly so as to furnish only sufficient air for supplying leakages. However, when the pressure in the brake-pipe is reduced for applying the brakes, the steam-valve is opened, and the pump rapidly produces in the main reservoir a surplus pressure, which insures the speedy release of the brakes and the recharging of the reservoirs. In designing this pump regulator, it has been found necessary, in order to secure accurate results, to make a rather complicated piece of mechanism, but its practical working is entirely satisfactory.

The advantages to be derived from the use of a regulating valve are so great as to render our charge of $25 each very reasonable. This regulator is only furnished when especially ordered, at the price mentioned.

AUXILIARY BRAKE-VALVE.

Plate A20 shows the auxiliary brake-valve, which is designed for use on lines having heavy gradients of great length, in descending which, with the automatic brake alone, it is necessary to release the brakes occasionally to recharge the reservoirs; and the object of this valve is to provide a second means of admitting and regulating the pressure of air in the brake-cylinders on the engine and tender, on lines where the gradients average 100 feet per mile, and on the cars in addition, where the gradients are steeper and of greater length. This valve is used with the second line of pipe having direct connection with the brake-cylinders on the engine and tender through the double check-valve, Plate A21, and also a similar connection with each of the other brake-cylinders where the second pipe is extended throughout the train. The graduating handle 3 terminates in a screw with a coarse thread. The valve 12 is held against its seat by the pressure of the air in the reservoir and by the spring 13. When the graduating handle 3 is turned, it compresses the spring 10 until it forces the valve 12 from its seat, which permits air to flow into the driving-wheel brake and tender cylinders until the pressure in these cylinders is sufficient to force the spring 10 up by acting on the piston 11, when the valve 12 again seats, preventing any further admission of air to the cylinders. Thus it will be seen that the amount of pressure admitted to the cylinders depends upon the extent to which the spring 10 is compressed by the graduating handle, which permits the application of the brakes to be perfectly graduated.

To release the brakes, the graduating handle is turned in an opposite direction, releasing the spring 10 from compression, when the pressure in the brake-pipe lifts the piston from the valve 12, and permits the air to escape through the holes in the upper part of the case. If it is desired to allow only a portion of the pressure to escape, the graduating handle is turned a corresponding distance, and the spring 10 seats the piston-valve when the desired amount of air has escaped.

DETAILS OF AUXILIARY BRAKE-VALVE.

PLATE A20.

Auxiliary Brake-Valve Complete, No. 33, Plate A5.

No.
1. Valve-case.
2. Upper Cap.
3. Graduating Handle.
4. Bottom Cap.
5. Reservoir-pipe Union.
6. Brake-pipe Union.
7. Bracket-nut.

No.
8. Spring-guide.
9. Piston.
10. Upper Spring.
11. Piston Packing-ring.
12. Central Valve.
13. Lower Spring.

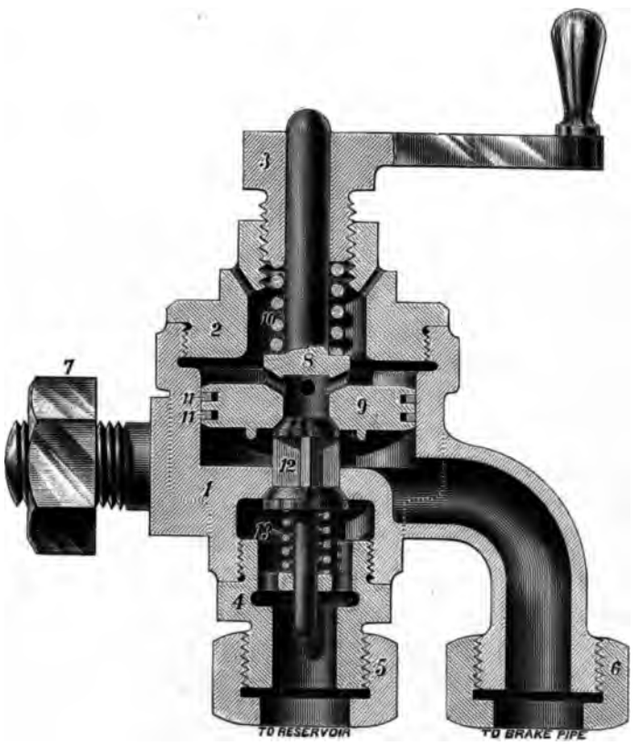
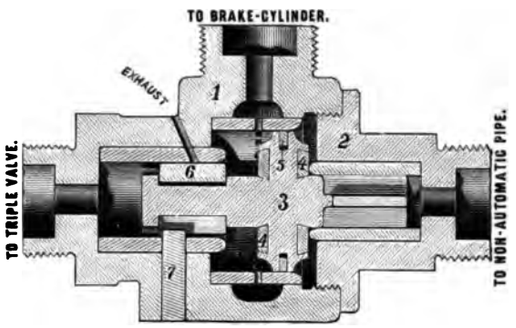


PLATE A20.



DETAILS OF DOUBLE CHECK-VALVE.

PLATE A21.

Double Check-Valve Complete, No. 29, Plate A5.

No.		No.	
1.	Valve-case.	5.	Piston Packing-ring.
2.	Valve-case Cap.	6.	Slide-valve.
3.	Piston.	7.	Slide-valve Guide.
4.	Valve-face.		

In ordering detached parts for repairs, please specify the plate and number of each piece accurately, to avoid errors.

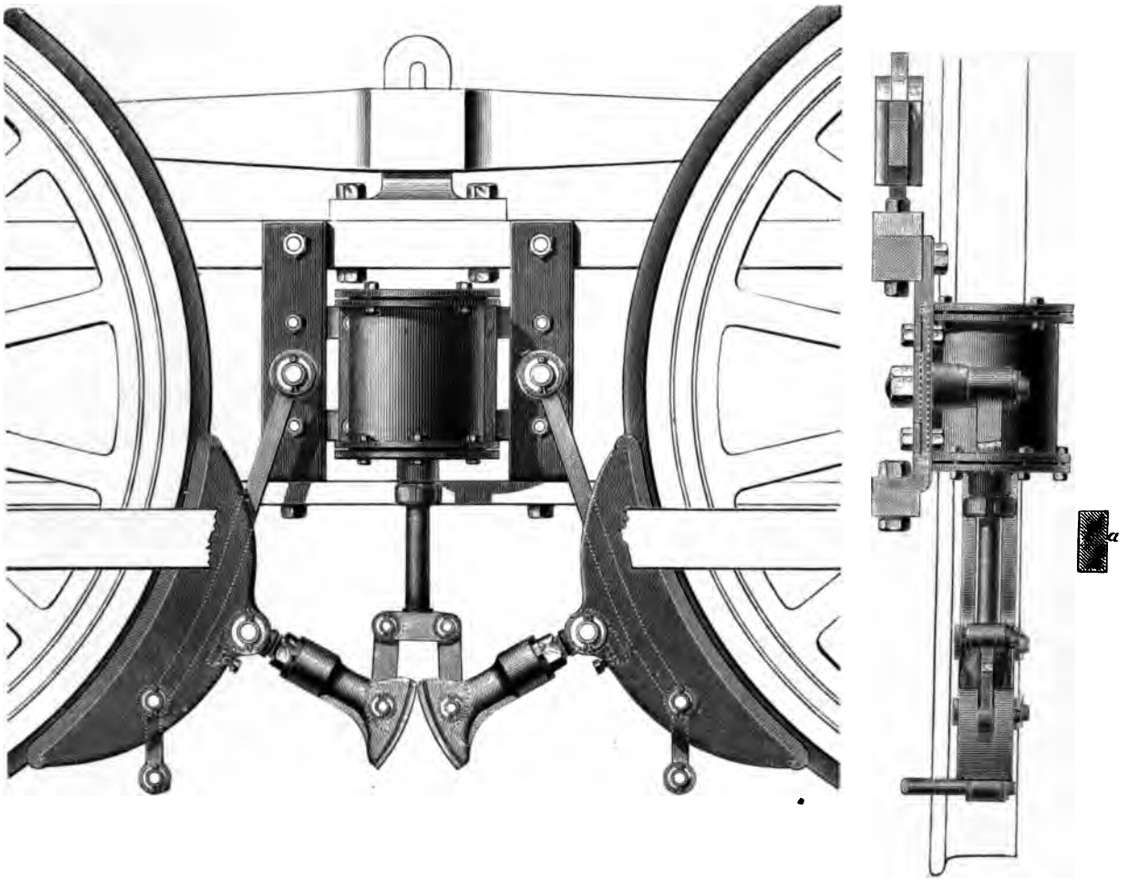
DOUBLE CHECK-VALVE.

Plate A21 shows the double check-valve referred to in the description of the auxiliary brake-valve. Connections are made to the non-automatic brake-pipe, to the triple valve, and to the brake-cylinder, as shown in the illustration. The piston 3, in the position shown, gives a free passage from the triple valve to the brake-cylinder, while the leather packing, 4, prevents air from passing to the non-automatic pipe. If, however, air be admitted from the non-automatic pipe, the piston 3 is forced in the opposite direction, and a passage is opened from the non-automatic pipe to the brake-cylinder, while the passage to the triple valve is closed. Even if the non-automatic brake is applied, a greater pressure coming from the triple valve will move the piston, hence the application of the automatic brake is not interfered with in case of emergency.

The piston 3 carries with it a slide-valve 6, which in the position shown covers a small exhaust port. The object of this is to enable the air to be discharged from all of the reservoirs, if the brakes should be applied automatically by the bursting of a hose or the breaking of the pipe. This is done by admitting a full reservoir pressure into the non-automatic pipe, which shifts the double check-valve, and allows the air in the auxiliary reservoirs to escape through the exhaust port, after which the non-automatic brake alone may be used. This arrangement obviates the necessity of going to each car to open the release-cocks.

DRIVING-WHEEL BRAKES.

PLATE A22.



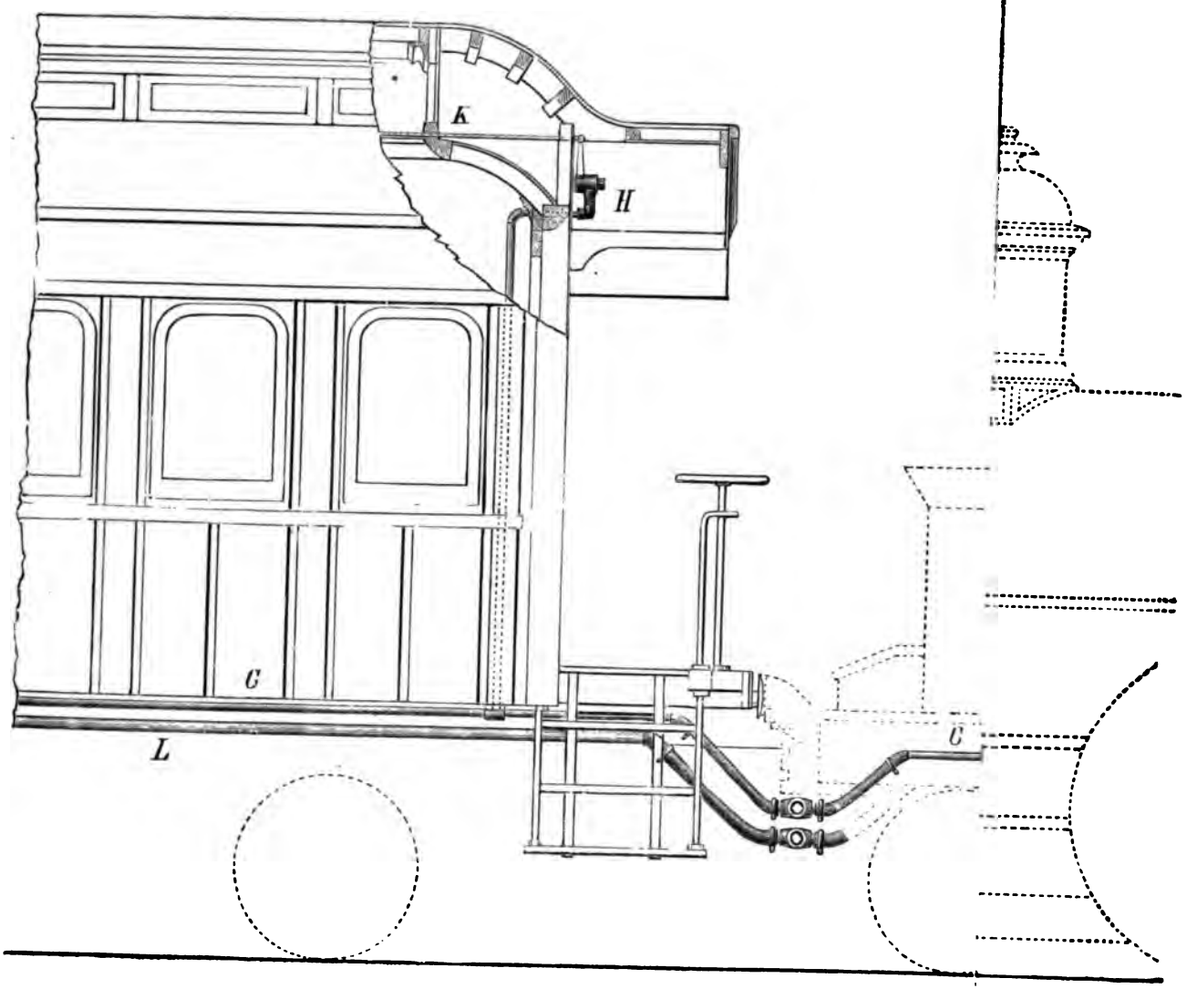
DRIVING-WHEEL BRAKES.

Plate A22 gives two views of our driving-wheel brakes as applied to an ordinary engine, the operation of which is clearly shown by the drawing. As will be seen by reference to our agreement, we furnish the two cylinders for operating the driving-wheel brakes on engines without extra charge when desired.

When these brakes are ordered, it is necessary that a sketch of the engine for which they are intended should be sent us, showing a side view of the driving-wheels and frame, and a cross-section through the frame between driving-wheels, with the side rod in its highest position; the diameter of driving-wheels, distance from center to center, and distance from frame to rail, should also be given with the other dimensions. In addition, the approximate weight of the driving-wheels on the track should be stated. On receipt of this sketch, we prepare complete working drawings for the application of the castings and forgings necessary to work the driving-wheel brakes; these castings and forgings can be made by the parties desiring to use them from the drawings which we furnish, or, if desired, we will furnish them at a price to be agreed upon, which will depend in a measure upon the class of engines to which the brakes are applied.

We cannot too strongly urge the importance of having engines fitted with these driving-wheel brakes, as a large amount of braking power is secured at a very slight additional cost.

The experience of several years has demonstrated the fact that their use produces no injurious effect upon the driving-wheels or connecting-rods of the locomotive, while in freight service it has been found that an engineer can stop a train with the driving-wheel brakes in about the time required by the usual force of brakemen. It should be noted that the blocks are pressed against the wheels by two levers having curved faces rolling upon each other, and that the centers of these curves vary in position to the weight of the engine, and are at such points in all cases that a given pressure on the brake-piston will produce a nearly constant force against the brake-blocks at all points of the stroke. Details of the driving-wheel brake-cylinder are given on Plates A17 and A18.



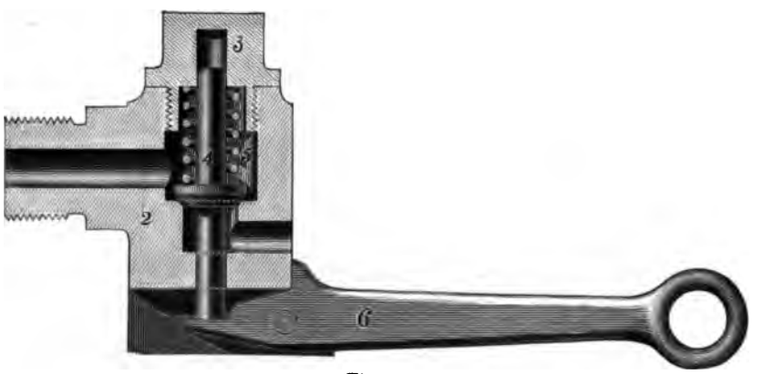


Fig. 1.

DETAILS OF SIGNALING APPARATUS.

PLATE A23.

FIGURE 1.

No.	
1.	Car Discharge-valve, complete.
2.	Discharge-valve Body.
3.	Cap-nut.
4.	Discharge-valve.
5.	Discharge-valve Spring.
6.	Cord-lever.

FIGURE 2.

No.	
1.	Signaling-valve, complete.
2.	Lower Diaphragm-case.
3.	Upper Diaphragm-case.
4.	Lower-cap Nut.
5.	Valve and Stem.
6.	Feed-valve.
7.	Feed-valve Nut.
8.	Upper Diaphragm-plate.
9.	Lower Diaphragm-plate.
10.	Diaphragm.
11.	Rubber Gasket.
12.	Diaphragm Spring.
13.	Eye-bolt.
14.	Eye-bolt Nut.

FIGURE 3.

No.	
1.	Reducing-valve, complete.
2.	Valve-body.
3.	Upper Cap.
4.	Lower Cap.
5.	Supply-valve.
6.	Diaphragm Plate.
7.	Diaphragm.
8.	Diaphragm Nut.
9.	Diaphragm Spring.
10.	Supply-valve Spring.

In ordering detached parts for repairs, please give the plate and number of each piece accurately, to avoid errors.

TRAIN SIGNALING APPARATUS.

We have for a number of years given attention to the question of signaling from the various cars to the engineer by the use of compressed air, and have perfected the arrangement which we illustrate on Plate A23, and which is now, after a trial of over a year, being applied to the Pennsylvania Railroad equipment. A separate line of pipe extends throughout the train, connected between the cars by hose and couplings; located in a convenient place in each car is a small valve, Fig. 1, the handle of which is connected to a cord running along the inside of the car, in the position usually occupied by the bell-cord. On the engine is a small reservoir, to one end of which is fastened what is called a signaling-valve, shown in Fig. 2. A second opening in this valve leads to the main signaling-pipe, and a third opening to a small whistle located in any convenient place on the engine. The main signaling-pipe receives air from the main reservoir through a reducing-valve, Fig. 3, which is so constructed that, notwithstanding a great variation of the pressure in the main reservoir, a constant moderate pressure of about fifteen pounds per square inch is maintained in the main signaling-pipe throughout the train, in the signaling-reservoir, and in the signaling-valve. This signaling-valve has a diaphragm, No. 10, dividing the valve into two chambers, A and B, the lower chamber being in communication with the signaling-reservoir, and the upper chamber with the brake-pipe. This diaphragm is so arranged that it allows air to pass freely from the main pipe to the signaling-reservoir, so that an equal pressure is usually maintained in both. When it is desired to give a signal, the car-valve, Fig. 1, is opened by pulling the cord, which reduces the pressure in the main pipe; the pressure in the reservoir, being greater, then moves the diaphragm in such a manner as to carry the valve 5 away from its seat, which permits a portion of the air in the reservoir to escape to the whistle and give a signal to the engineer.

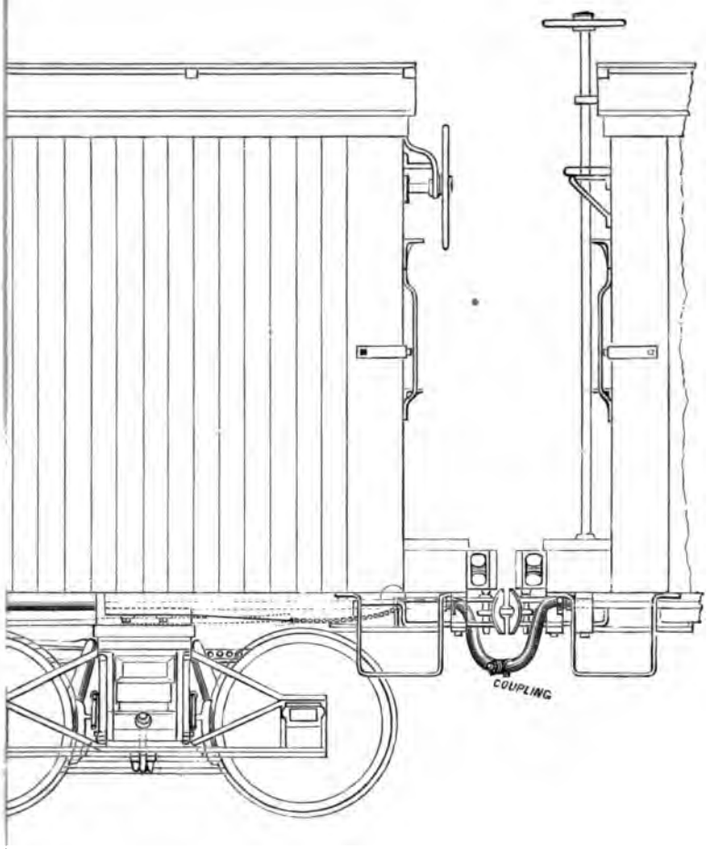
Signals can be given at the rate of four or five per second with great certainty. If the train breaks in two, the whistle is blown loudly for a con-

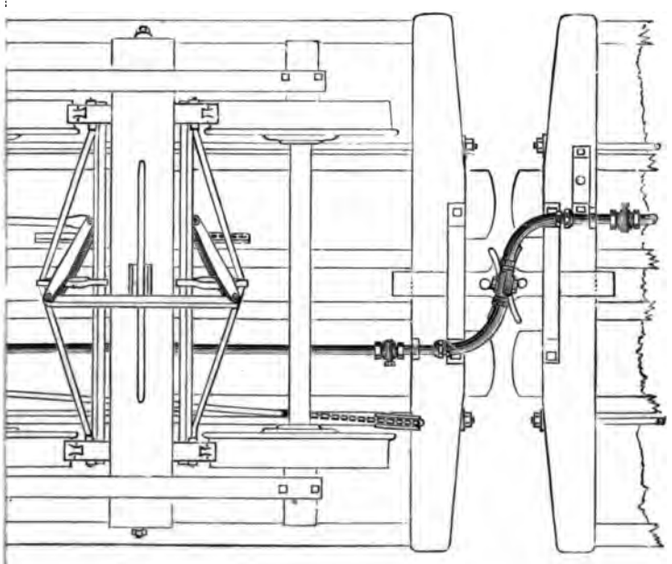
siderable time. We furnish the apparatus complete, including pipe and couplings, at $20 per car and $35 per engine.

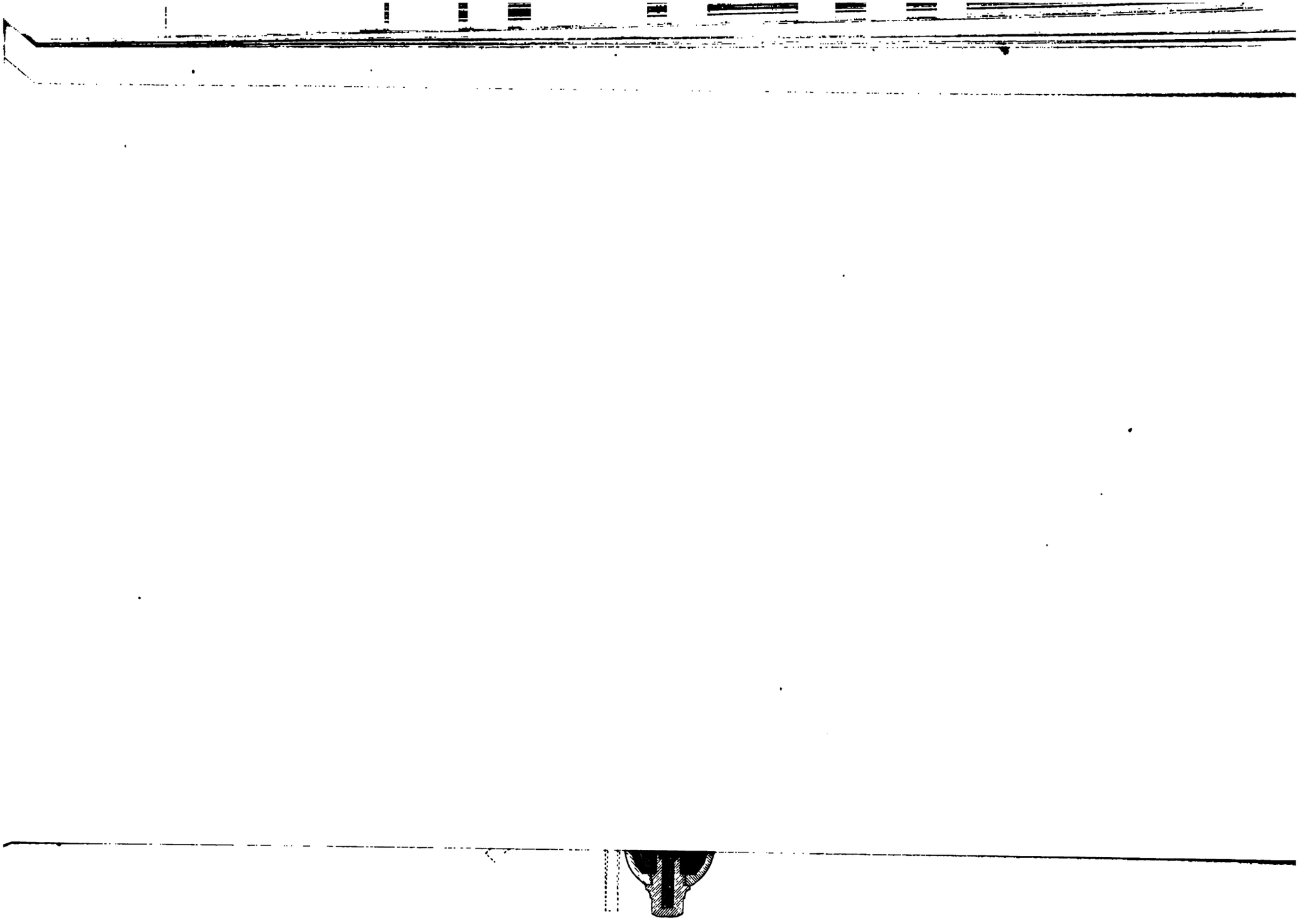
We believe that the ease and certainty with which signals can be given will quite justify the above expenditure,—in fact, we know that it will work its way into general use as soon as its merits are fully known. The present bell-cord has been submitted to patiently for years, simply because heretofore a satisfactory substitute has not been offered, notwithstanding repeated efforts in this direction.

FREIGHT-BRAKES.

Plate A24 illustrates our automatic freight-brake, which has been successfully used upon a train of fifty cars. The operation of this brake is in all respects similar to that of the passenger-brake previously described; the triple valve, brake-cylinder, and reservoir are, however, all bolted together, thus avoiding the pipe connections usually employed with the passenger apparatus. The triple valve operates in precisely the same manner, and therefore no description is necessary. The pump best suited for supplying air for the freight-brake is that shown on Plate A7, the capacity of which is about double that of the standard pump for passenger engines. After a long experience, we have become satisfied that a non-automatic brake cannot be made to work upon more than from ten to twelve cars with any satisfaction, while we have found, as stated above, that it is possible to work trains of fifty cars with the automatic brake without difficulty. With the non-automatic brake the air is stored upon the engine and transmitted back through the pipe, and consequently there is a great loss of time both in putting on and taking off the brakes. With the automatic brake, the air is stored upon each car ready for use, and this supply is readily brought into action by a slight reduction of pressure in the main pipe, which reduction requires the movement of a trifling quantity of air as compared with that used for setting a non-automatic brake. A careful analysis of accidents shows that a much greater number will be prevented by having a brake which will act of its own accord in case of the train breaking in two. We do not pretend to offer our brake in competition with the so-called buffer or concussion brakes, because we know that these latter can never be made to apply themselves automatically when the train breaks in two, and therefore will never fulfill the necessary requirements. By a simple valve, shown on Plate A30, which can be placed in the couplings in any portion of the train, the brakes are divided into two sections, so that the engineer can at will apply the brakes on the front section alone or upon both, as may be found necessary.


COUPLING





The price for these brakes, when used for freight cars only, will be $50 per set. The price for the apparatus for the engine is the same as for that used on a passenger engine, the same parts being furnished excepting the larger pump shown on Plate A7.

When desired, as on very steep grades, say from one hundred feet to the mile and upward, we supply a second line of pipe with couplings, whereby a constant pressure can be maintained in all the brake-cylinders, the double check-valve illustrated on Plate A21 being used. When air is admitted into the second line of pipe, it moves the double check-valve so as to open a passage to the brake-cylinder.

In fitting our apparatus to the cars, more or less difficulty has been experienced, owing to carelessness in permitting the scales and dirt to get into the triple valves, and we have designed what we call a car drain-cup (No. 27, Plate A5), which is so constructed that it will be impossible for sand, grit, or moisture to enter the triple valves. This takes the place of a common "T" piece usually inserted in the main pipe to make the connection to the triple valve.

A section of the triple valve, brake-cylinder, and reservoir is shown on Plate A25, and an enlarged sectional view of the triple valve is shown on Plate A26.

FREIGHT-BRAKE TRIPLE VALVE.

Plate A26 shows the triple valve designed for use in connection with freight-brakes when only a single line of pipe is used, the operation of which is essentially the same as that of the standard triple valve used on passenger cars.

DETAILS OF FREIGHT-BRAKE TRIPLE VALVE.

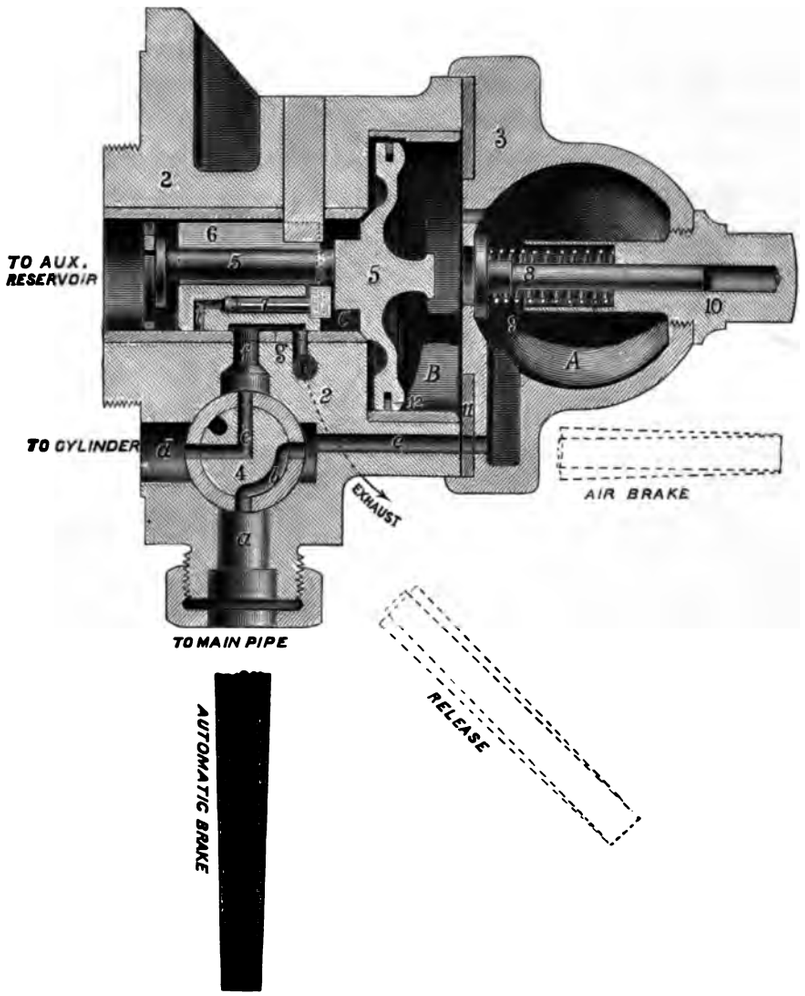
PLATE A26.

No.		No.	
1.	Freight-brake Triple Valve, complete.	7.	Graduating-valve.
2.	Valve-case.	8.	Graduating-stem.
3.	Drain-cup.	9.	Graduating-spring.
4.	Four-way Cock Plug.	10.	Graduating-stem Nut.
5.	Piston.	11.	Triple-valve Gasket.
6.	Slide-valve.	12.	Piston Packing-ring.

In ordering detached parts for repairs, please give the plate and number of each piece accurately, to avoid errors.

FREIGHT-BRAKE TRIPLE VALVE.

PLATE A26.



TRIPLE VALVE WITH DOUBLE CHECK.

PLATE A27.

Plate A27 shows the form of triple valve used in connection with the double line of pipe—that is, one pipe for the automatic brake, and the other for the plain or the non-automatic brake.

Instead of a separate check-valve, as illustrated by Plate A5, No. 20, the double check-valve is combined with the triple valve, thus avoiding numerous joints, the operation of both valves being precisely the same. The four-way cock, in this case, instead of changing the brake from the automatic to the non-automatic system, serves to cut out the brake apparatus when desired, and, secondly, as a release-cock for letting the air out of the brake-cylinders if accidentally applied.

DETAILS OF TRIPLE VALVE WITH DOUBLE CHECK.

PLATE A27.

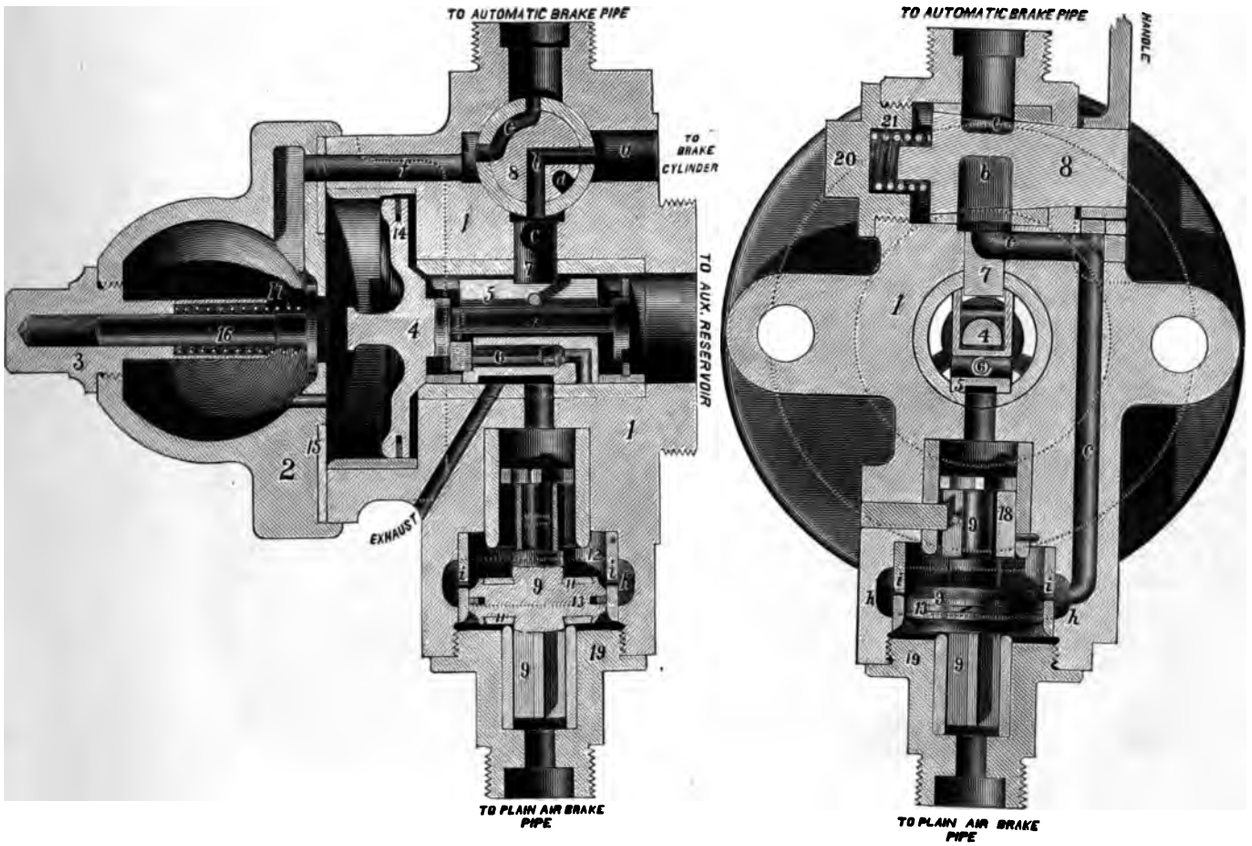
No.
1. Triple-valve Case.
2. Drain-cup.
3. Drain-cup Nut.
4. Piston.
5. Slide-valve.
6. Graduating-valve.
7. Guide-pin.
8. Four-way Cock Plug.
9. Double Check-valve.
10. Upper-valve Bush.
11. Valve-face.

No.
12. Lower-valve Bush.
13. Double Check-valve Packing-ring.
14. Piston Packing-ring.
15. Triple-valve Gasket.
16. Graduating-stem.
17. Graduating-spring.
18. Auxiliary Release-valve.
19. Double Check-valve Cap.
20. Four-way Cock Cap.
21. Four-way Cock Spring.

In ordering detached parts for repairs, please give the plate and number of each piece accurately, to avoid errors.

TRIPLE VALVE WITH DOUBLE CHECK.

PLATE A27.



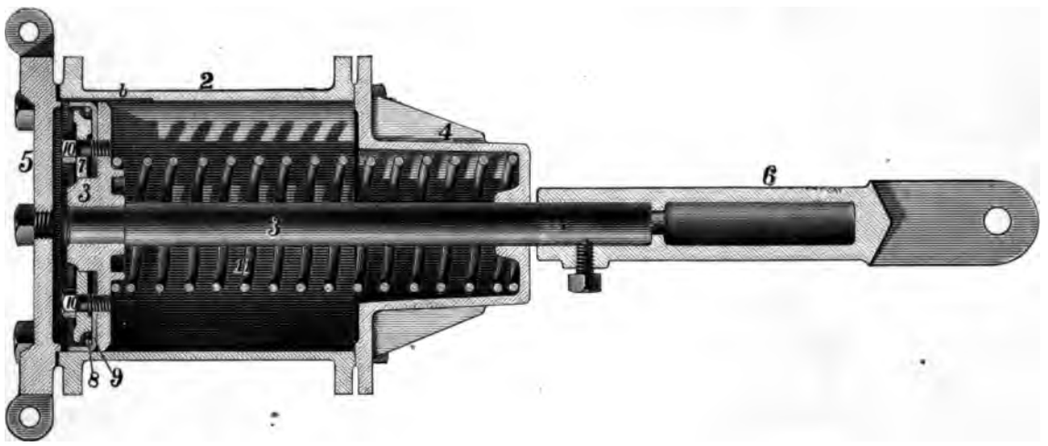
RESERVOIR AND TRIPLE VALVE COMBINED.

Plate A28 shows the reservoir and triple valve combined, without the brake-cylinder; used in some instances where, owing to lack of room, it is inconvenient to place so large a piece of mechanism as the cylinder, reservoir, and triple valve combined. The triple valve shown in connection with this reservoir is the same as that shown in the previous illustration; although the other form shown on Plate A26 can be used when so desired.

PLATE A28.

FREIGHT BRAKE-CYLINDER—NARROW GAUGE.

Plate A29 shows the form of brake-cylinder used for the non-automatic freight-brake on narrow-gauge cars, which can also be used with the reservoir and triple valve shown on Plate A28.



DETAILS OF FREIGHT BRAKE-CYLINDER FOR NARROW-GAUGE CARS.

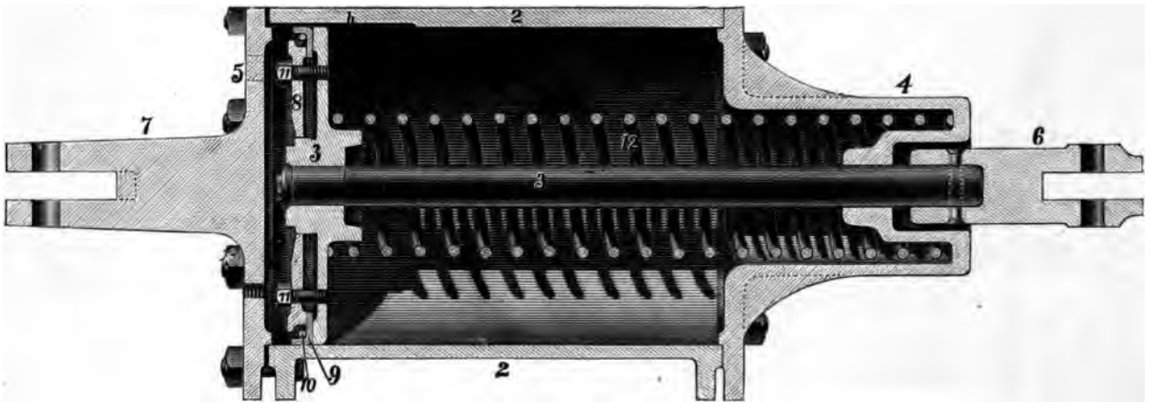
PLATE A29.

No.		No.	
1.	Freight Brake-cylinder for Narrow-gauge Cars, complete.	6.	Piston-sleeve.
2.	Cylinder-body.	7.	Piston-follower.
3.	Piston and rod.	8.	Packing-leather Expander.
4.	Back Head.	9.	Piston Packing-leather.
5.	Front Head.	10.	Piston-follower Bolt.
		11.	Release-spring.

In ordering detached parts for repairs, please specify the plate and number of each piece accurately, to avoid errors.

STANDARD FREIGHT BRAKE-CYLINDER.

The cylinder shown on Plate A30 is used on full-gauge freight-cars where the reservoir and triple valve are arranged as shown on Plate A28.



DETAILS OF FREIGHT BRAKE-CYLINDER.

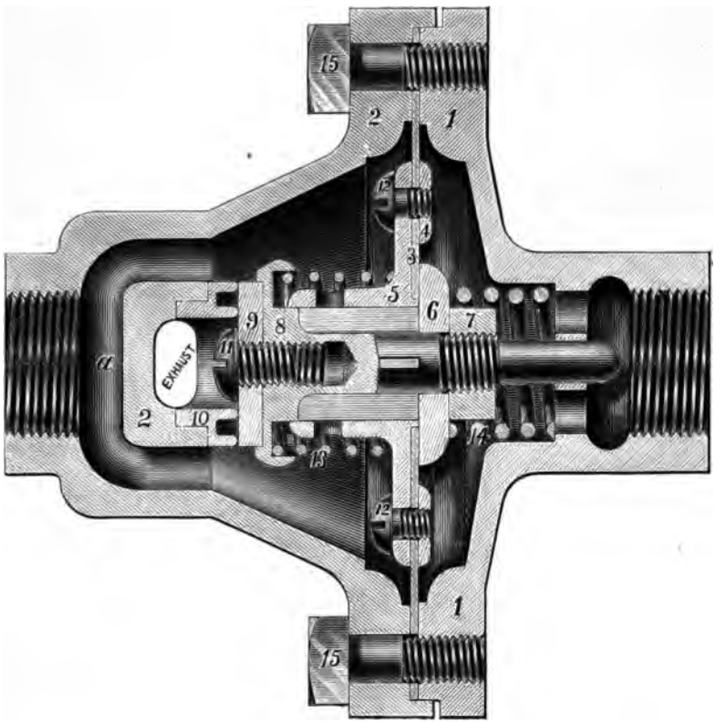
PLATE A30.

No.		No.	
1.	Freight Brake-cylinder for Standard-gauge Cars, complete.	7.	Lever-bracket.
2.	Cylinder Body.	8.	Piston-follower.
3.	Piston and Rod.	9.	Piston Packing-leather.
4.	Back Cylinder-head.	10.	Packing-leather Expander.
5.	Front Cylinder-head.	11.	Piston-follower Bolt.
6.	Cross Head.	12.	Release-spring.

In ordering detached parts for repairs, please specify the plate and number of each piece accurately, to avoid errors.

DETAILS OF AUXILIARY DISCHARGE-VALVE.

PLATE A31.



No.		No.	
1.	Front Cap.	9.	Discharge-valve Face.
2.	Valve-body.	10.	Discharge-valve Seat.
3.	Diaphragm.	11.	Discharge-valve Screw.
4.	Front Diaphragm-plate.	12.	Diaphragm-screw.
5.	Back Diaphragm-plate.	13.	Discharge-valve Spring.
6.	Diaphragm Seat.	14.	Diaphragm-spring.
7.	Diaphragm-seat Nut.	15.	Cap-screw.
8.	Discharge-valve.		

In ordering detached parts for repairs, please specify the plate and number of each piece accurately, to avoid errors.

AUXILIARY DISCHARGE-VALVE.

Plate A31 shows the auxiliary discharge-valve for freight cars. When the brakes are to be worked on an excessively long train, say fifty cars or more, it has been found expedient to use the twenty-five or thirty cars next the engine for ordinary stops; retaining, however, the maximum pressure in the entire train to be used in cases of emergency. This is done by the intervention of the auxiliary discharge-valve here shown. This valve is provided with an ordinary half-coupling at each end, so that it can be inserted between the train couplings, at any desirable point of the train. The valve consists of two chambers, divided by the diaphragm 3, which is clamped between the plates 4 and 5.

Air enters through the front end, which must in all cases be placed toward the engine; the exhaust being at the end toward the rear of the train. The air pressure entering overcomes the light spring 13, and forces the diaphragm from the seat 6, which permits the air to flow through the central annular space in the diaphragm to the opposite chamber, and thence to the rear of the train. The spring 14 is of sufficient strength to withstand a pressure of about ten pounds per square inch on the diaphragm; hence when the brakes are applied at the front of the train, by a reduction of less than ten pounds, the discharge-valve remains seated, and the brakes at the rear of the train are not applied. Should, however, a greater reduction than ten pounds be made in the brake-pipe, the pressure at the rear of the train will overcome the diaphragm-spring 14, and force the discharge-valve 9 from its seat 10; when the air will escape from the exhaust-port, thus applying the brakes at the rear of the train also.

Should the train break in two behind the auxiliary discharge-valve, the air escaping will permit the pressure at the front of the train to open the valve 6, when the pressure in the forward cars will escape through the diaphragm and through the open pipe; thus applying the brakes to the forward portion of the train as well as to the rear. Thus it will be seen that, while only the first twenty-five cars are used in ordinary braking, at the same time the braking power of the entire train can be called upon whenever necessary.

APPENDIX.

APPENDIX.

INSTRUCTIONS.

GENERAL. In making up trains, all couplings must be united so that the brakes will apply throughout the entire train. The cocks in the brake-pipe must all be opened (handles pointing down), except that on the rear of the last car, which must be closed.

In detaching engines or cars, the couplings must invariably be parted by hand; the cocks in the main brake-pipes must always be closed *before* separating the couplings, to prevent application of the brakes.

If the brakes are applied when the engine is not attached to the train or car, they can be released by opening the release-cock usually put in the end of the brake-cylinder.

The adjustment of the brake gear should be such that, when the brakes are full on, the pistons in the brake-cylinders will not have traveled to exceed eight or nine inches. This will allow for wear of shoes, stretching of rods, springing of brake-beams, etc.

Great care must be exercised, when taking up the slack in the brake connections, to have the levers and pistons pushed back to their proper places, and the slack taken up by the under connections or dead levers.

The brake-cylinders must always be kept clean, so that they will readily release when the air has been discharged, and should be oiled once in three months. The last date of oiling should be marked on the cylinder with chalk.

For the automatic brake, the handle of the four-way cock must be turned horizontally. If turned down, it will be changed to the simple air-

brake; if turned midway between these two positions, it will close communication with the brake-cylinder and reservoir, and should be so turned when desirable to have the brakes out of use on any particular car, on account of the breaking of rods, etc. It is very important, in order to avoid detentions, to keep the handles of these four-way cocks in their proper positions.

In cold weather the triple valve should be drained frequently, to let out any water that may have collected. Slack the bottom nut of the triple valve about half a turn, let the water escape, and screw it up again. The main pipe on the tender should be provided with a separate drain-cup with a cock, so that it can be drained daily in cold weather. The valve for the application of the brakes from the inside of the car should be kept tight, and must be examined by the inspectors.

ENGINEERS must see that the steam-cylinder is kept well lubricated; that the air-cylinder is sparingly lubricated with a small quantity of 28° gravity West Virginia well oil (tallow or lard oil must not be used in the air-cylinder); that the pump is constantly run, but never faster than is necessary to maintain the required air pressure: and that air from fifty to sixty pounds pressure for low speed or way trains, and from seventy to eighty pounds pressure for express trains, is carried.

For ordinary stops, the brakes should be applied lightly by opening the valve or cock, and closing it gently when the pressure has been reduced from four to eight pounds on the gauge.

The brakes are fully applied when the pressure as shown on the gauge is reduced twenty pounds. Any further reduction is a waste of air.

In releasing the brakes, the handle of the brake-valve must be moved quite against the stop, and be kept there for about ten seconds, and then moved back against the intermediate stop, which is the feed position, and where it must remain while the train is running.

Engineers, upon finding that the brakes have been applied by the train men, or automatically, must at once aid in stopping the train by turning the handle of the brake-valve toward the right, thus preventing escape of air from the main reservoir.

The shoes of the driving-wheel brakes should be so adjusted by turning the screws that the pistons move up from three to four inches when the brakes are applied.

It is important to drain the water out of the main reservoir once a week, especially in winter-time, and oftener if the pump-rod is not kept well packed.

If cars having different air pressures be coupled together, the brakes will apply themselves on those which have the highest pressure. To insure the certain release of all of the brakes in the train, and also that trains may be charged quickly, the engineer must carry the maximum pressure in the main reservoir before connecting to a train, and then put the handle of his brake-valve in the release position until the train is charged with air. If the brakes on the engine and tender thus apply themselves by being coupled to a train not charged, they should at once be taken off by opening the release-cock from the brake-cylinders, which ought to be so arranged as to be worked from the foot-plate.

TRAIN MEN. After making up or adding to a train, or after a change of engines, the rear brakeman shall ascertain whether the brake is connected throughout the train.

When hose couplings are not used for connecting the brakes between two vehicles, they must be attached to their dummy couplings.

When there is occasion to apply the brakes from the cars, the valve must be held open to allow the air to escape until the train is brought to a stand-still; but this method of application should only be used in cases of emergency.

Train men must in all cases see that the hand-brakes are off before starting.

Before detaching the engine or any carriages, the brakes must be fully released on the whole train. Neglecting this precaution, or setting the brakes by opening a valve or cock when the engine is detached, may cause serious inconvenience in switching.

The pipes and joints must be kept tight, and when leaks are discovered they should be corrected, if serious, before the car is again used.

HOW TO APPLY AND RELEASE THE WESTINGHOUSE AUTOMATIC BRAKE.

The brakes, as has been explained, are applied when the pressure in the brake-pipe is suddenly reduced, and released when the pressure is restored.

It is of very great importance that every engineer should bear in mind that the air pressure may sometimes reduce slowly, owing to the steam pressure getting low, or from the stopping of the pump, or from a leakage in some of the pipes when one or more cars are detached for switching purposes, and that in consequence it has been found absolutely necessary to provide each cylinder with what is called a leakage groove, which permits a slight pressure to escape without moving the piston, thus preventing the application of the brakes when the pressure is slowly reduced, as would result from any of the above causes.

This provision against the accidental application of the brakes must be taken into consideration, or else it will sometimes happen that all of the brakes will not be applied when such is the intention, simply because the air has been discharged so slowly from the brake-pipe that it only represents a considerable leakage, and thus allows the air under some cars to be wasted.

It is thus very essential to discharge enough air in the first instance, and with sufficient rapidity, to cause all of the leakage-grooves to be closed, which will remain closed until the brakes have been released. In no case should the reduction in the brake-pipe for closing the leakage-grooves be less than four or five pounds, which will move all pistons out so that the brake-shoes will be only slightly bearing against the wheels. After this first reduction the pressure can be reduced to suit the circumstances.

On a long train, if the three-way cock be opened suddenly, and then quickly closed, the pressure in the brake-pipe, as indicated by the gauge, will be suddenly and considerably reduced on the engine, and will

then be increased by the air pressure coming from the rear of the train; hence it is important to always close the three-way cock slowly, and in such a manner that the pressure as indicated by the gauge will not be increased, or else the brakes on the engine and tender, and sometimes on the first one or two cars, will come off when they should remain on. It is likewise very important, while the brakes are on, to keep the three-way cock in such a position that the brake-pipe pressure cannot be increased by leakage from the main reservoir, for any increase of pressure in the brake-pipe causes the brakes to come off.

On long down-grades it is important to be able to control the speed of the train, and at the same time to maintain a good working pressure. This is easily accomplished by running the pump at a good speed, so that the main reservoir will accumulate a high pressure while the brakes are on. When, after using the brake some time, the pressure has been reduced to sixty pounds, the train pipes and reservoirs should be recharged as much as possible before the speed has increased to the maximum allowed. A greater time for recharging is obtained by considerably reducing the speed of the train just before recharging and by taking advantage of the variation in the grades.

There should not be any safety-valve or leaks in the main reservoir, otherwise the necessary surplus pressure for quickly recharging cannot be obtained.

To release the brakes with certainty, it is important to have a higher pressure in the main reservoir than in the main pipe. If an engineer feels that some of his brakes are not off, it is best to turn the handle of the three-way cock just far enough to shut off the main reservoir and then pump up fifteen or twenty pounds extra, which will insure the release of all of the brakes; all of which can be done while the train is in motion.

For ordinary stops, great economy in the use of air is effected by, in the first instance, letting out from eight to twelve pounds pressure while the train is at speed, taking care to begin a sufficient distance from the station.

BRAKE POWER.

To obtain the best results, it is important to have the braking force proportioned to the weight of the car, or, more particularly speaking, to the load carried by those wheels upon which brakes act. After long experience, it has been decided to recommend such a proportion of brake-levers that a pressure of 50 pounds per square inch on the brake-piston will bring a force against the brake-blocks on each pair of wheels equal to the load carried by them; thus, owing to a great variation of cars, it is impossible to have uniform brake-levers.

For convenience, it has been found best to cut the brake connection which joins the brakes of both trucks, and to interpose at this point the brake cylinder, having with it two levers and a tie-rod. With this arrangement it is only necessary to get the proper proportion of these cylinder levers.

The following rules will enable those whose duty it is to attach brakes to proportion the levers so as to carry out the foregoing recommendation.

RULES FOR CALCULATING CAR-LEVERS.

The air pressure is rated at fifty (50) pounds per square inch on piston, when the brakes are fully applied. (50 pounds per square inch gives about 4,000 pounds for 10-inch cylinder, and 2,500 pounds for 8-inch cylinder.)

To find the leverage required—Divide the weight of the car resting upon the brake wheels by the *whole* pressure on piston.

To find proportion of brake-beam levers—Divide the *whole* length of lever by short end.

To find the total brake-beam leverage—Multiply proportion of lever by two (2) for the *Hodge* system, and by four (4) for the *Stevens*.

To find proportion of cylinder lever—Multiply the whole length of lever by either the required leverage or the *total* brake-beam leverage, and divide by the sum of both; the result will give the length of one end of the lever.

If the required leverage is greater than the *total* brake-beam leverage, the long end of lever must go next to the cylinder; if less, the short end must go next to the cylinder.

Dead levers must be made in the same proportion as the other truck levers.

EXAMPLE — HODGE SYSTEM.

Weight of car	36,000	pounds.
Total pressure on 10-inch piston	4,000	"
Total length of brake-beam lever	28	inches.
Length of short end of brake-beam lever	7	"
Total length of cylinder lever	24	"

$36{,}000 \div 4{,}000 = 9$, leverage required.

$28 \div 7 = 4 \times 2 = 8$, total brake-beam leverage.

$24 \times 8 = 192 \div (8 + 9) = 11.3$, short end cylinder lever.

$24 - 11.3 = 12.7$, long end cylinder lever.

EXAMPLE — STEVENS'S SYSTEM.

Total length of cylinder lever, 36 inches.

$36{,}000 \div 4{,}000 = 9$, leverage required.

$28 \div 7 = 4 \times 4 = 16$, total brake-beam leverage.

$36 \times 9 = 324 \div (9 + 16) = 12.96$, short end cylinder lever.

$36 - 12.96 = 23.04$, long end cylinder lever.

WESTINGHOUSE BRAKE APPARATUS

Is manufactured under the protection of various United States patents, which the Brake Company either own, or under which they are specially licensed.

We append hereto a list of these patents, classified with approximate accuracy, though some of them embrace features which are used in the construction of different classes of apparatus. Such patents will be enumerated only in the class to which they primarily relate, since an enumeration in each class would make the list too long.

I. WESTINGHOUSE "COMPRESSED AIR" (NON-AUTOMATIC) BRAKE PATENTS.

No.	Date.	Name.
88,929	April 13th, 1869	George Westinghouse, Jr.
5,504 (Re-issue)	July 29th, 1873	" "
117,841	August 8th, 1871	" "
5,505 (Re-issue)	July 29th, 1873	" "
122,544	January 9th, 1872	" "
123,067	" 23d, "	" "
124,403	March 5th, "	" "
125,639	April 9th, "	Thomas W. Welsh.
134,178	December 24th, 1872	George Westinghouse, Jr.
142,600	September 9th, 1873	" "
144,582	November 11th, "	" "
149,902	April 21st, 1874	" "
162,465	" 27th, 1875	Walter J. Ford, George Westinghouse, Jr., and Thomas W. Welsh.
166,405	August 3d, 1875	H. L. Perrine.
166,406	" " "	" "
169,575	November 2d, 1875	" "
203,647	May 14th, 1878	William G. Raoul.
216,545	June 17th, 1879	George Westinghouse, Jr.
222,803	December 23d, 1879	" "

II. WESTINGHOUSE AUTOMATIC AIR-BRAKE PATENTS.

No.	Date.	Name.
124,404	March 5th, 1872	George Westinghouse, Jr.
124,405	" " "	" "
134,177	December 24th, 1872	" "
138,827	May 13th, 1873	" "

No.	Date.	Name.
141,685	August 12th, 1873	George Westinghouse, Jr.
144,006	October 28th, "	" "
149,901	April 21st, 1874	" "
156,322	October 27th, 1874	" "
156,323	" " "	" "
160,955	March 16th, 1875	James R. Reniff.
163,242	May 11th, "	Charles H. Perkins.
168,359	October 5th, "	George Westinghouse, Jr.
172,064	January 11th, 1876	" "
193,279	July 17th, 1877	H. L. Perrine.
214,337	April 15th, 1879	George Westinghouse, Jr.
180,179	July 25th, 1876	" "
214,602	April 22d, 1879	" "
214,603	" " "	" "
217,836	July 22d, "	" "
217,838	" " "	" "
218,149	August 5th, "	" "
218,150	" " "	" "
220,556	October 14th, 1879	" "
225,898	March 23d, 1880	" "
235,922	December 28th, 1880	" "

III. HOSE-COUPLING PATENTS.

No.	Date.	Name.
64,437	May 7th, 1867	Barney Mee.
109,695	November 29th, 1870	George Westinghouse, Jr.
115,917	June 13th, 1871	Levi Wharton.
116,655	July 4th, "	George Westinghouse, Jr.
122,873	January 16th, 1872	Thomas W. Welsh.
136,396	March 4th, 1873	George Westinghouse, Jr.
136,397	" " "	" "
136,631	" 11th, "	" "
146,367	January 13th, 1874	John Y. Smith.
157,951	December 22d, "	George Westinghouse, Jr.
8,291 (Re-issue)	June 18th, 1878	" "
166,489	August 10th, 1875	" "
214,334	April 15th, 1879	H. H. Westinghouse.
214,335	" " "	George Westinghouse, Jr.
214,336	" " "	" "
221,987	November 25th, 1879	Thomas W. Welsh.
224,256	February 3d, 1879	Charles G. Welch.
236,388	January 4th, 1881	George Westinghouse, Jr.

IV. DRIVING-WHEEL BRAKE PATENTS.

No.	Date.	Name.
144,005	October 28th, 1873	George Westinghouse, Jr.
147,212	February 3d, 1874	" "
175,886	April 11th, 1876	" "

V. AIR-PUMP AND ENGINE PATENTS.

No.	Date.	Name.
106,899	August 30th, 1870	George Westinghouse, Jr.
115,668	June 6th, 1871	" "
131,985	October 8th, 1872	" "
138,828	May 13th, 1873	" "
159,782	February 16th, 1875	" "
136,806	March 18th, 1873	John Bailey.
157,671	December 15th, 1874	" "
183,206	October 10th, 1876	James R. Reniff.

VI. VACUUM-BRAKE PATENTS (NON-AUTOMATIC).

No.	Date.	Name.
28,670 (Extended)	June 12th, 1860	Nehemiah Hodge.
8,971	November 18th, 1879	" "
114,083	April 25th, 1871	Henry W. Adams.
115,667	June 6th, "	George Westinghouse, Jr.
2,506 (Re-issue)	July 29th, 1873	" "
9,478	November 23d, 1880	" "
129,868	July 23d, 1872	John Y. Smith.
130,323	August 6th, 1872	" "
136,779	March 11th, 1873	" "
136,780	" " "	" "
136,781	" " "	" "
160,903	May 16th, 1875	George Westinghouse, Jr.
163,612	" 25th, "	John Y. Smith.
169,118	September 25th, 1875	George Westinghouse, Jr.

VII. WESTINGHOUSE AUTOMATIC VACUUM-BRAKE PATENTS.

No.	Date.	Name.
134,408	December 31st, 1872	George Westinghouse, Jr.
6,948 (Re-issue)	February 22d, 1876	" "
217,837	July 22d, 1879	" "

RAILWAYS USING THE WESTINGHOUSE AUTOMATIC BRAKE.

Pennsylvania Railroad.
Pittsburgh, Cincin. & St. Louis R'y.
Union Pacific Railway.
Michigan Central R. R.
Lake Shore & Mich. Southern Railway.
Pittsburgh, Ft. Wayne & Chicago R'y.
Chicago, Rock Island & Pacific R. R.
Chicago, Burlington & Quincy R. R.
Old Colony R. R.
Boston & Providence R. R.
Cleveland & Pittsburgh R. R.
New-York Cen. & Hudson River R. R.
Columbus, Hocking Val. & Toledo R. R.
Western & Atlantic R. R.
Baltimore & Ohio R. R.
Philadelphia, Wilmington & Balt. R. R.
Cleveland, Columbus, Cin. & Ind. R. R.
Northern Central Railway.
Missouri Pacific Railway.
Indiana, Bloomington & Western R. R.
Terre Haute & Indianapolis R. R.
Cincinnati, Hamilton & Dayton R. R.
Mobile & Ohio R. R.
Grand Rapids & Indiana R. R.
Flint & Pere Marquette R. R.
Boston & Albany R. R.
Georgia R. R.
Louisville & Nashville R. R.
Richmond, Fredericks. & Potomac R. R.
Concord R. R.
Missouri, Kansas & Texas Railway.
Denver & Rio Grande Railway.
Hannibal & St. Joseph R. R.
Canada Southern Railway.
East Tennessee, Virginia & Geo. R. R.
Atchison, Topeka & Santa Fé R. R.
Delaware, Lackawanna & Western R. R.
Atlantic & Pacific Railway.
St. Louis & San Francisco R'y.
Cleve. Tuscar. Valley & Wheeling R.R.
Great Western Railway of Canada.
International & Great Northern R'y.
Cumberland Valley R. R.
Delaware & Hudson Canal Co.
New-York & New England R. R.
Philadelphia & Reading R. R.
Lehigh Valley R. R.
Chicago & Alton R. R.
Wabash, St. Louis & Pacific Railway.
Illinois Midland R. R.
St. Louis, Iron Mountain & South. R'y.
South Carolina Railway.
Chicago, St. Paul, Minn. & Omaha R. R.
New Orleans & Mobile R. R.
New London Northern Railway.
New-York & Harlem R. R.
Boston, Concord & Montreal R. R.
Concord & Claremont R. R.
Montpelier & Wells River R. R.
Southern Central of New-York.

Burlington & Missouri River R. R.
Chicago, Pekin & South-western R'y.
St. Louis, Keokuk & N. W. R'y.
Chicago, Milwaukee & St. Paul R'y.
Cincinnati & Westwood R. R.
North Pennsylvania R. R.
Richmond & Danville R. R.
Scioto Valley R. R.
Chicago & Grand Trunk R'y.
New-York, Lake Erie & Western R. R.
Ulster & Delaware R. R.
Wilmington, Columbia & Augusta R.R.
Wilmington & Weldon R. R.
Charlotte, Columbia & Augusta R. R.
South-western R. R. of Georgia.
Atlanta & Charlotte Air Line Railway.
Norfolk & Western R. R.
Denver Pacific R. R.
Central R. R. of New Jersey.
Western R. R. of Cuba.
Minneapolis & St. Louis R. R.
Seaboard & Roanoke R. R.
Evansville, Terre Haute & Chic. R. R.
Ches. Ohio & South-western R. R.
Cincinnati Southern Railway.
Lake Erie & Western.
Northern Pacific R. R.
Colorado Central R. R.
Wallkill Valley R. R.
New-York, Penna. & Ohio R. R.
Camden & Atlantic R. R.
Central R. R. of Georgia.
Brooklyn, Flatbush & Coney Is. R. R.
Pittsburgh & Lake Erie R. R.
Alabama & Great Southern R. R.
Providence & Worcester R. R.
Sioux City & Pacific R. R.
St. Paul, Minneapolis & Manitoba.
Central Branch Union Pacific R. R.
Raleigh & Gaston R. R.
Buffalo & South-western R. R.
West Chester & Philadelphia R. R.
Savannah, Florida & Western.
Wisconsin Central R. R.
Green Bay, Winona & St. Paul R'y.
Memphis & Little Rock R. R.
Naugatuck R. R.
Southern Minnesota Railway.
Louisville, New Albany & Chic. R'y.
Danbury & Norwalk R. R.
Bennington & Rutland Railway.
Worcester & Nashua R. R.
Canadian Pacific Railway.
St. Paul & Duluth R. R.
Columbia & Greenville R. R.
Danville & South-western R. R.
Kansas City, Ft. Scott & Gulf R. R.
Valley Railway of Ohio.
Spartanburg, Union & Col. R. R.
Nantasket Beach R. R.
Ind's, Decatur & Springfield R. R.
South Mountain R. R.
Cincinnati, Sandusky & Cleveland R.R.
Chicago & Eastern Illinois.
Carolina Central R. R.
Selma, Rome & Dalton R. R.
Ohio Central Railway.
New-York, Susquehanna & Western.
Whitefield & Jefferson R. R.
Cumberland & Pennsylvania R. R.

Atlan. Gulf & West India Transit R. R.
Dom Pedro 2d Railway. (Of Brazil.)
Toledo, Delphos & Burlington R. R.
Rio Grande Extension Co.
Mexican National Railway.
Macon & Brunswick R. R.
Galveston, Houston & Henderson R.R.
Peoria, Decatur & Evansville R. R.
East Line & Red River R. R.
Ithaca, Auburn & Western R. R.
Rochester & Pittsburgh R. R.
Port Royal & Augusta R. R.
Credit Valley R'y.
Oregonian Railway Co. (Limited).
Chicago & North-western Railway.
Jeffersonville, Madison & Indianap. R.R.
Illinois Central R. R.
New-York, New Haven & Hartford R.R.
Ohio & Mississippi R. R.
Des Moines Valley R. R.
Kan. City, St. Jo. & Council Bluffs R.R.
Louisville, Cincinnati & Lexington R. R.
Baltimore & Potomac R. R.
New Haven & Northampton Railway.
Hartford & Connecticut Western R. R.
Memphis & Charleston R. R.
Evansville & Terre Haute R. R.
Nashville, Chattanooga & St. Louis R'y.
Fitchburg R. R.
Eastern R. R.
Indianapolis & St. Louis R. R.
Kansas City, Law. & Southern Kansas R. R.
New-York, Providence & Boston R. R.
Rock Island & Peoria Railway.
Western, of Alabama.
Chesapeake & Ohio R. R.
Northern (N. H.) R. R.
Texas & Pacific Railway.
Cleveland, Akron & Columbus R. R.
St. Louis, Alton & Terre Haute R. R.
Houston & Texas Central R. R.
Troy & Boston R. R.
New-York, Ontario & Western R. R.
Adirondack R. R.
Shenandoah Valley R. R.
Jacksonville & South-eastern R. R.
Eliza., Lex. & Big Sandy River R. R.
Ogdensburg & Lake Champlain R'y.
Kentucky Central R'y.
Danville, Olney & Ohio River R'y.
Harrisburg & Potomac R. R.
Portland & Rochester R. R.
Cincinnati Northern R. R.
Mexican Central R. R. (Limited).
Detroit, Mackinac & Marquette R'y.
Grand Trunk Railway of Canada.
Oregon & California R. R.
Northern Pacific R. R., N. M.
Sonora Railway Co. (Limited).
New-York, West Shore & Buffalo R'y.
Wheeling & Lake Erie R'y.

RAILWAYS USING THE WESTINGHOUSE BRAKE.

(NON-AUTOMATIC.)

Buffalo, Pittsburgh & Western R. R.
Allegheny Valley R. R.
Cin., Indianap., St. Louis & Chic. R. R.
White Water R. R.
Central Pacific R. R.
Hartford & Connecticut Western R. R.
St. Joseph & Western R. R.
Atlanta & West Point R. R.
Fort Wayne, Muncie & Cincinnati R'y.
Burling., Cedar Rapids & Northern R'y.
Detroit, Grand Harbor & Mil. R. R.
Chic., St. Louis & New Orleans R. R.
Central Iowa.
Central Vermont.
Connecticut River R. R.
Petersburg R. R.
Vermont & Mass. R. R.
Richmond & Petersburg R. R.
Cincinnati, Lafayette & Chicago R'y.
Dunkirk, Allegheny Val. & Pittsb. R. R.
Cheshire R. R.
Buffalo, Corry & Pittsburgh R. R.
New-York, Boston & Montreal R. R.
Marquette, Houghton & Onton. R. R.
Buffalo, New-York & Philadelphia R.R.
Sussex Railway.
Dayton & Union R. R.
Connecticut & Passumpsic River R. R.
Morgan's Louisiana & Texas Railway.
Karns City & Butler R. R.
North Pacific Coast R. R.
Virginia & Truckee R. R.
Cleveland & Marietta R. R.
Eastern and Maine Central R. Rs.
Southern Pacific R. R.
Cairo & Vincennes R. R.
Chicago & West Michigan R. R.
Providence, Warren & Bristol R. R.
Santa Clara R. R.
Vicksburg & Meridian R. R.
Boston & New-York Air Line Railway.
Cincinnati & Eastern Railway.
Columbus, Hocking Valley & Toledo R. R.
Detroit, Lansing & Northern Railway.
Galveston, Harrisburg & San Ant. R'y.
Eastern Kentucky Railway.
Paducah & Elizabethtown Railway.
Republic of Ecuador.
Mexico & Vera Cruz Railway.
Logansport & Terre Haute R. R.
South Pacific Coast R. R.
Olean, Bradford & Warren R. R.
Detroit and Bay City R. R.
South-eastern Railway of Canada.
Toledo & Ann Arbor R. R.
Eureka & Palisade R. R.
Profile & Franconia Notch R. R.
Ashland Coal & Iron Railway.
Port Huron & North-western Railway.